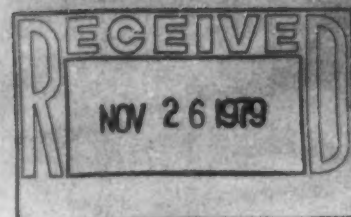


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THE COVER



Underground storage of natural gas requires miles of piping at the surface—and miles of pipelines to transport it to the gas distribution systems' mains and services that deliver the efficient fuel to heat homes and industries at peak demand times of winter.

—Photo courtesy Northern Indiana Public Service Co.

Peakshaving Report 22

U.S. peakshaving capabilities will be at a record high for the 1979-1980 winter season as underground gas storage capacity and withdrawal/sendout capacity reach new peaks and LNG peakshaving capacity reaches an all-time high; new peakshaving capacity is 69.86 billion cu ft per day.

Underground Gas Storage Data 24

Complete listing of companies who operate underground gas storage reservoirs including information on facilities in use.

LNG Scorecard 26

Latest tabulation on U.S., Canadian, and International peakshaving facilities, including both large and small satellite plants.

Consumers' Gas LNG Satellite Firms Ottawa Valley Gas Supply 30

New LNG peakshaving satellite plant, supplied from Montreal LNG peakshaving/liquefaction plant, is ideally located in middle of service area and has proven itself in both emergencies and for peakshaving service.

Northwest Natural Newport LNG Plant First To Use CRYEX Purification 40

New concept for removing carbon dioxide from gas stream is incorporated into Northwest Natural Gas Co.'s LNG peakshaving facility on Yaquina Bay 114 miles southwest of Portland, Oregon.

Colonial's 1979 Expansion A Struggle With Weather 50

Latest season in Colonial Pipeline Co.'s continuing expansion program involved 278 miles of pipeline and 116,900 hp installed at a total cost of over \$214 million.

Gastech 79 Conference/Exhibition To Host Over 1000 In Houston 60

International energy authorities and representatives from the worldwide energy supply, transportation, and distribution business to meet in Houston on November 13-16.

Windmill Powers Cathodic Protection System 70

It is almost perpetual power...the windmill-mounted power generator used by Texas Eastern Gas Pipeline Co. to power its cathodic protection system on a remote stretch of 30-in. gas pipeline in deep south Texas.

Peakshaving Report



Plant operator checks valves at storage area of the propane-air facility of Gas Company of New Mexico at Albuquerque. Plant is one of nearly 500 utilized by gas industry to meet peak winter demands.

—courtesy Southern Union Co

Peakshaving Capabilities Ready For '79-'80 Winter Season

by Dean Hale, Editor

There will be plenty of peakshaving capacity available during the 1979-1980 winter heating season to enable the gas industry to meet needs of its customers. That capacity — 69.86 billion cu ft over a 24-hr period — comes on top of an increase in regularly scheduled deliveries — to an estimated 64.5 Bcf/day — by gas pipeline suppliers. Projected maximum delivery in one day, should it happen that all valves be opened, could reach as high as 134 billion cu ft in one 24-hr period, according to data gathered in PIPELINE & GAS JOURNAL's annual peakshaving survey.

Such an occurrence isn't likely, however. The entire nation is not likely to experience a major cold wave on a single day. And it is possible that field production curtailments could reduce pipeline flows up to 10%. Still, the amount available is about 69% greater than the 79+ Bcf reported as the peak-day total gas sendout during the 1978-1979 winter heating season.

For the 1979-1980 winter, a peak-day gas sendout total of 80 to 84 Bcf in 24 hr is considered most probably unless Mother Nature delivers an extended deep-freeze over a large area of the country.

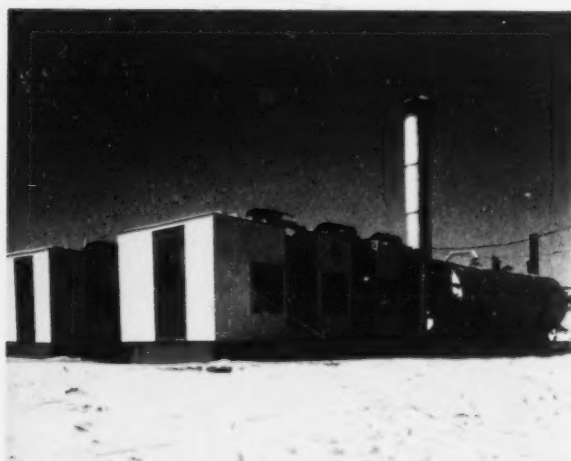
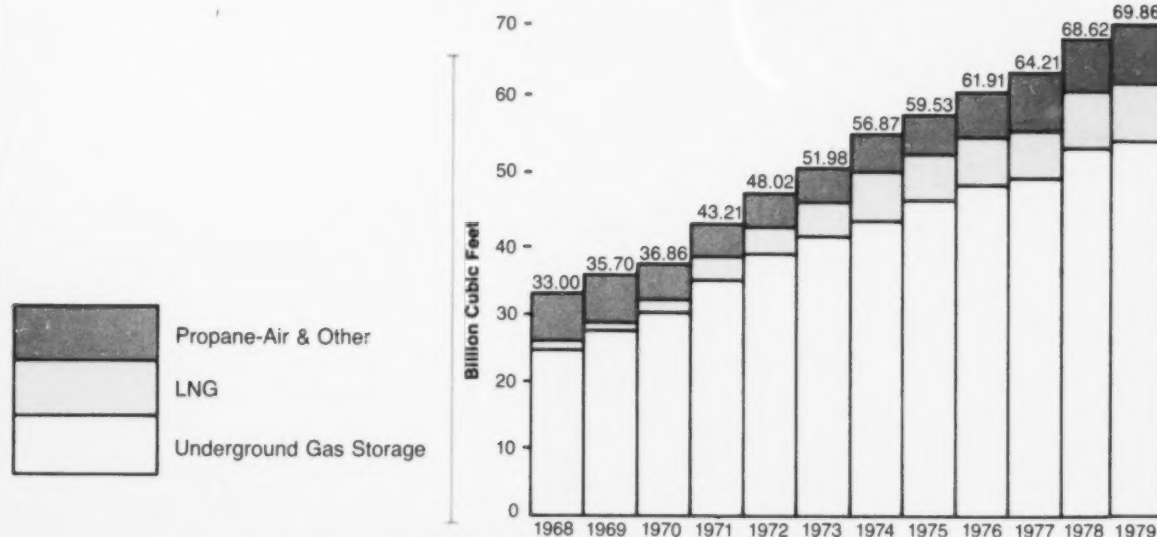
Supplemental gas supplies will be providing for a good chunk of gas demand at any one time in some area of the country—perhaps 50% to 70% in some instances—but industry authorities told PIPELINE & GAS JOURNAL that there is little possibility of an extraordinary high delivery day beyond the 84 Bcf point.

For the 1979-1980 winter season, peakshaving supplies will include:

- 55.39 Bcf from underground gas storage
- 5.11 Bcf from propane-air plants
- 8.98 Bcf from LNG peakshaving and satellite plants
- 0.38 Bcf from other sources

Major increase during 1979 over 1978 figures is in deliverability from underground gas storage facilities—approximately a 2% increase and 1.01 Bcf. Deliverability by LNG peakshaving plants and satellite facilities gained 2.4%, while propane-air plants' increased by slightly less than 1%. "Other" sources include sendout from SNG plants operated for peakshaving purposes (mothballing of SNG facilities has increased notably in recent months as government regulations prevent them from operating

Supplemental Gas Supplies For Peakshaving-1968-1979



—courtesy Applied Engineering Co.

Framingham, Mass., propane-air plant of Worcester Gas Light Co. provides sendout of 20 million cu ft per day at 100 psig.

economically, along with line pack, buried bottle-type storage, gas holders, and enrichment of gas stream by direct injection of propane or ethane or boost Btu content.

Underground Gas Storage Activity

The search for new underground gas storage fields and continuing expansion and modernization of existing storage facilities continued its march during 1979.

As of November 1, 1979, there were 406 gas storage fields belonging to 89 companies, of which 377 are classified as active, 19 are considered as being under development, seven are planned, and three are "being depleted" and will no longer be used. Total capacity of the fields (working gas plus cushion gas) exceeds 7.254 trillion cu ft while working capacity is estimated at 3.561 trillion cu ft. Maximum deliverability is estimated at 55.391 billion cu ft in a 24-hr period, according to PIPELINE & GAS JOURNAL's peakshaving survey data.

Expenditures of \$243,169,000 for new underground storage facilities (drilling and completing wells, installing field lines, and installing compressor horsepower and other related measurement, filtering, and dehydrating equipment and controls) were reported. Expenditures for 1980 for underground gas storage facilities by gas utilities and gas transmission pipeline companies are expected to exceed \$285,000,000, according to the survey.

At the 396 operating and under-development gas storage fields, current statistics indicate there are 17,652 wells (a net increase of 234 over 1978), 6818 miles of field lines (up a net 136 miles over 1978), and a net gain of three compressor stations with a net increase of 41,900 hp for the year.

Outlook for 1980 underground gas storage developments:

ANR Storage Co. plans include development of four fields in Michigan—Rapid River 35, Cold Springs 12, Cold Springs 31, and Excelsior 6. The first two are part of a nearly \$66-million program to provide storage for five major gas companies. The latter two will be developed as part of a \$26.6-million program recently announced.

National Fuel Gas Storage Corp. plans to spend \$64,753,575 to expand three fields—East Independence, West Independence, and Beech Hill (all in New York)—to provide 23.5 Bcf storage capacity in which 11 other gas companies would be able to reserve up to 16.05 Bcf storage for their accounts. Program would take three years to complete.

Washington Natural Gas Co., as operator for a three-company joint venture at Jackson Prairie gas storage in Washington State, plans to continue development of the field's Zone 9. In an application filed at end of August to FERC, WNG indicated that deliveries to Northwest Pipeline Corp. from the field would be increased to 325,000 Mcf per day plus an additional 71,800 Mcf per day on a best-efforts basis.

Panhandle Eastern Pipe Line Co. plans to increase storage capacity of the Tuscola field in Illinois (Mt. Simon formation) to 9 Bcf and plans to add a 1000-hp compressor that will go into service in early 1980. PEPL also is continuing development of the Montezuma field in Indiana.

Southwest Gas Storage Co., a joint venture of Panhandle Eastern and ANR Storage Co., has asked FERC for author-

U.S. Underground Gas Storage Operations — Operating Companies — 1979 Data

Company	No. of Fields	No. of Wells	Miles Storage Lines	Storage Compressor Stations	
				No.	HP
ANR Storage Co.	4	(under development)	3	27,000	
Arkansas Louisiana Gas Co.	4	52	22.00	4	35,415
Arkansas Oklahoma Gas Corp.	1	12	3.00	1	370
Arkansas Western Gas Co.	4	11	3.72	4	1,175
Battle Creek Gas Co.	2	2	N/A	1	600
Bear Creek Storage Co.	1	— (1 under development)	—	—	—
Brady, Tex., Municipal Gas Corp.	1	2	2.00	1	420
Cabot Corp.	2	14	14.60	2	2,395
Central Illinois Light Co.	2	86	21.27	2	4,265
Central Illinois Public Service	3	78	9.80	3	3,220
Cities Service Gas Co.	10	589	164.00	6	29,800
Citizens Gas & Coke Utility	8	182	319.00	2	3,695
Colorado Interstate Gas Co.	4	122	230.00	3	9,700
Columbia Gas Transmission Corp.	51	3,626	1,175.40	28	105,335
Columbia Gas of Pennsylvania Consolidated Gas Supply	owned 9 joint 4	1,040 296	458.00 117.00	9 8	119,300 60,390
Consumers Power Co.	13	1,336	575.00	17	179,690
Delhi Gas Pipeline Corp.	11	477	128.66	4	78,810
East Ohio Gas Co.	1	— (under development)	—	—	—
El Paso Natural Gas Co.	4	756	253.02	3	20,220
	2	35	39.00	1	4,400
	— (1 planned)	—	—	—	—
Equitable Gas Co.	15	280	148.10	9	15,580
Felmont Oil Corp.	1	10	6.00	1	1,050
Gas Utilities (Ill.)	1	6	3.10	—	—
Hampshire Gas Co.	1	13	17.00	1	1,640
Honeye Storage Corp.	1	34	15.80	1	2,200
Hoosier Gas Corp.	3	24	8.30	0	—
Houston Pipe Line Co.	1	42	10.00	1	12,660
Illinois Power Co.	8	237	34.75	8	12,100
Indiana Gas Co.	7	272	106.06	2	2,602
Kane Gas Light & Heat Co.	1	21	10.00	1	60
Kansas Nebraska Natural Gas	4	32	23.40	3	5,530
Laclede Gas Co.	1	50	31.58	1	9,020
Lawrenceburg Gas Co.	1	1	—	—	—
Lone Star Gas Co.	12	112	78.58	11	25,275
Louisville Gas & Electric Co.	9	834	126.16	3	18,900
LoVaca Gathering Co.	2	—	—	—	—
Michigan Consolidated Gas Co.	5	483	90.00	4	71,000
Michigan Gas Storage	3	554	166.10	1	30,900
Michigan Gas Utilities Co.	1	4	3.00	1	800
Michigan Wisconsin Pipe Line Co.	14	1,140	295.00	7	88,500
	— (1 under development)	—	—	1	6,000
Midwestern Gas Transmission Co.	3	55	11.70	2	1,593
Minnesota Gas Co.	1	40	15.00	1	2,200
Mississippi River Transmission Corp.	3	66	72.06	3	22,050
Mississippi Valley Gas Co.	1	3	1.00	1	584
Montana-Dakota Utilities Co.	3	87	103.00	3	20,222
Montana Power Co.	4	37	38.00	3	5,670
Mountain Fuel Resources Inc.	1	19	15.5	1	28,400
Mountain Fuel Supply Co.	3	26	10.0	3	5,500
Mustang Fuel Corp.	1	1	4.00	—	—
Natural Fuel Gas Supply Corp.	owned 30 joint 4	951 329	486.80 63.10	14 (4)	237 (39,900)
	Total 34	1,280	549.90	14	237
	— (3 under development)	—	—	—	—
National Gas & Oil Corp.	3	31	8.00	3	1,950
National Zinc Co.	1	7	—	1	119
Natural Gas Pipeline Co. of America	13	850	305.00	8	119,040
North Penn Gas Co.	owned 2 (joint 1)	18	12.70	1	4,995
Northern Gas Co.	4	8	13.00	4	1,900
Northern Illinois Gas Co.	7	505	264.03	6	113,990
Northern Indiana Public Service	3	135	29.00	2	7,320
Northern Natural Gas Co.	3	293	128.50	2	15,960
Oklahoma Natural Gas Co.	4	62	22.00	2	11,500
Pacific Gas & Electric Co.	3	95	22.47	3	10,990
Panhandle Eastern Pipe Line Co.	4	203	109.00	4	19,450
Peoples Gas Light & Coke Co., The	1	137	189.00	1	14,900
Peoples Natural Gas Co.	8	80	34.00	5	10,720
Peoples Natural Gas Div., Western Region, Northern Natural Gas	1	1	2.00	1	75
T. W. Phillips Gas & Oil Co.	7	74	—	7	1,995
Phillips Petroleum Co.	3	6	22.00	2	620
Pioneer Natural Gas Co.	2	1	1.00	1	880
	— (1 under development)	—	—	—	—
Public Service Co. of Colorado	1	13	8.27	1	17,000
Saxonburg Heat & Light Co.	3	6	3.00	2	50
South Louisiana Production Co.	1	3	10.00	1	30
	2	6	2.00	1	2,600
Southeastern Michigan Gas Co.	2	83	17.30	2	1,500
Southern Indiana Gas & Electric Co.	1	73	48.22	1	21,750
Southern Natural Gas Co.	7	311	89.70	6	104,090
Southern California Gas Co.	— (1 under development)	—	—	—	—
Southern Union Co. (Gas Co. of New Mex.)	1	11	12.00	1	3,000
Southwest Gas Storage Co.	1	— (planned)	—	—	—
Southwestern Gas Pipeline, Inc.	2	11	3.45	1	440
Tennessee Gas Pipeline Co. (joint)	4	345	2.00	2	19,600
Texas Eastern Transmission Corp.	owned 1	69	27.20	1	11,000
Texas Gas Transmission Corp.	10	447	244.60	11	17,515
Transcontinental Gas Pipe Line Corp.	owned 3 (joint 2)	56 181	22.45 79.00	3 2	46,100 34,300
Trunkline Gas Co.	1	— (under development)	—	—	—
Union Gas System, Inc.	5	115	25.00	2	660
Union Light, Heat & Power Co.	1	25	28.00	—	—
United Gas Pipe Line Co.	owned 1 joint 1	19 73	6.10 21.70	1 1	2,550 34,000
	Total 2	92	27.80	2	36,550
Victor Gas Co.	1	6	12.00	2	300
Washington Natural Gas	joint 1	77	9.10	1	12,500
Washington Water Power Co. Northwest Pipeline Corp.					
Western Kentucky Gas Co.	6	58	19.30	4	1,555
Western Slope Gas Co.	2	9	8.80	1	650

ity to develop Borchers North Field in Meade County, Kans., at a cost of \$72,970,000. That would involve drilling and completing 30 new injection-withdrawal wells, working over 19 existing wells, installing 30 miles of field lines, and installing 15,000 hp in a compressor station. Total field capacity would be 70,082 MMcf, and maximum working capacity would be 35,000 MMcf.

Arkansas Louisiana Gas Co. plans to continue develop-

ment in 1980 on Chiles Dome Storage Field in Oklahoma. Total project cost will be \$30 million.

Battle Creek Gas Co. is developing the Cal-Lee fields for storage in Calhoun County, Mich., at a cost of \$6 million.

El Paso Natural Gas Co. plans to develop the Washington Ranch Field in Eddy County, N.M., for gas storage at a cost of \$53 million.

Consumers Power Co. is developing the Marsac Creek



—courtesy Chicago Bridge and Iron Co.

Burnsville, Minn., LNG facility of Minnesota Gas Co., left, in operation since 1978, is part of Minnegasco's comprehensive peakshaving operations at this location. At right are refrigerated storage (large tank with 'Minnegasco' painted on the side) and conventional storage for propane, used to manufacture propane-air for the utility system.

Field in St. Clair County, Mich., for gas storage.

Colorado Interstate Gas Co. is developing Flank Field for underground gas storage in Baca County, Colo., at a cost of approximately \$17 million.

Equitable Gas Co. will continue development in 1980 of Shirley Field, Tyler County, W. Va.

Indiana Gas Co. continues to develop new underground gas storage and has two exploratory projects underway.

Northern Indiana Public Service Co. will spend \$2 million on development of Grass Creek Field in Fulton, Pulaski, and Cass counties, Ind.

Southern California Gas Co. is developing Ten Section Field in Kern County, Calif., for underground gas storage. The \$131 million project will be 50% owned by Pacific Gas and Electric Co.

Texas Gas Transmission Co. plans to spend approximately \$2 million during 1980 to further develop its 10 gas storage fields in Kentucky and Indiana.

Propane-Air Plants

Propane-air plants in the U.S. now total 494 and are operated by 243 gas utilities in 40 states. Deliverability of these facilities has increased to 5.11 billion cu ft per day. An additional 12.3 million gal. of propane storage was added at new and existing propane-air facilities during 1979.

LNG Peakshaving Developments

Southwest Gas Corp. hopes to get construction of its planned \$23,467,000 peakshaving facility underway in time to begin liquefaction in July 1981. This would enable Southwest to provide peakshaving in the 1981-82 heating season. Southwest had to abandon the original site it chose for the facility because of seismic considerations. If used, the site would not have been in compliance with the proposed federal regulations, under Part 193. An alternative site has been selected that is less seismically sensitive. CBI will build the facility.

Northern Indiana Public Service Co.'s second LNG peakshaving plant is now under construction at LaPorte, Ind. Completion is scheduled for September-October 1980. The facility is a "duplicate" of NIPSCO's existing plant. CBI expects to complete the LNG storage tank in early 1980 with completion of the liquefaction facility following during summer 1980.

Energy Terminal Services continues to process its application before the FERC to construct and operate a peakshaving plant at its Staten Island LNG terminal site. Congressman J. Murphy (D-N.Y.) appears to have extended his opposition to the use of the Staten Island facility as an LNG terminal to its use for peakshaving. The facility is located in his congressional district. Strangely enough, Congressman Murphy reportedly is not opposed to the siting of other facilities in urban areas provided they meet what he considers to be applicable safety standards.

The Department of Transportation's Materials Transportation Bureau (MTB) had not issued its new standards for LNG facilities as of the end of September. Staff was still reviewing the numerous comments submitted to its Notice of Proposed Rulemaking by the LNG industry and the public. The staff is also reviewing the report submitted by the Technical Pipeline Safety Standards Committee on the proposed standards. The MTB had hoped to issue regulations covering facility design and construction, Part 193, Subparts A-K, in September.

The Senate passed its bill S.411 Pipeline Safety Act of 1979, on June 4; H.R. 51, Fuels Transportation Safety Amendment Act of 1979, was expected to be passed by the House of Representatives in September. Both these bills modify the Natural Gas Pipeline Safety Act of 1968, which enables MTB to issue LNG regulations. Only the House version contains provisions calling for the Secretary of Transportation to issue new regulations covering both new and existing LNG facilities. The new regulations would add requirements in such areas as financial responsibility.

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SCORECARD

U.S. and Canadian LNG Peakshaving Facilities

November 1979

Company and Plant Site	Liquefaction Plant Capacity, Mscfd/day	Storage Capacity, MMBbl	Total Design Capacity, MMBbl	Regasification - MMBbl			Type of Storage	Storage Equipment	Liquefaction Plant Contractor	Type of Cycle	Year of Operation	
				Runs	No. of Reg.	Typ.						
APCI-NEGEA Hopkinton, Mass.	18.5	2000 (2 at 290)	580	248	4 at 62	8	Submrgd	Aboveground, 9% nickel	CBI	Cryo-Methane	Cascade	1967 - plant; 1971 on new tanks
APCI-NEGEA Hopkinton, Mass.	—	1000	290	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1975 - third tank
ALABAMA GAS CORP. Birmingham, Ala.	4.65	625	180	127/85	3 at 42.5	10	Submrgd	Aboveground, 9% nickel	CBI	Air Products & Chemicals, Inc.	Cascade	1965
ALABAMA GAS CORP. Birmingham, Ala.	—	625	180	42.5	1 at 42.5	—	Submrgd	Aboveground, 9% nickel	CBI	—	—	1971 - second tank
ALABAMA GAS CORP. Cordova, Ala.	2.7	600	175	80	2 at 40	15	Submrgd	Aboveground, aluminum	CBI	CBI	Modified Cascade	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga.	10.0	1000	290	200	3 at 100	5	Uniflux	Aboveground, aluminum	CBI	Air Liquide	TEAL Expander Process boost	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga.	—	1500	450	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1973
ARKANSAS-MISSOURI POWER CO. Yarbark Ark.	0.66	374 (2 x 55)	110	66	2 at 33	6	Direct	Aboveground, aluminum	Brown, Minneapolis Tank & Fab. Co.	Process Constructors, Inc.	Stirling	1973 - (1972 as satellite)
BALTIMORE GAS & ELEC. CO. Baltimore, Md.	2.75	500 (2 x 72.5)	145	187.5/125	3 at 62.5	5	Submrgd	Aboveground, aluminum	CBI	CBI	Expander	1971
BALTIMORE GAS & ELEC. CO. PLANT No. 2, Baltimore, Md.	2.4	500	145	62.5	1 at 62.5	8	Submrgd	Aboveground, aluminum	CBI	CBI	MRL	1973
BAY STATE GAS CO. Ludlow, Mass.	7.5	1000	290	55	1 at 25	20	Uniflux	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1973
BOSTON GAS CO. Boston, Mass.	6.0	1000	290	187.5/125	3 at 62.5	8	Submrgd	Aboveground, 9% nickel	CBI	CBI	Expander	1968
BOSTON GAS CO. Boston, Mass.	—	1120	331	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1971 - second tank
BOSTON GAS CO. Lynn, Mass.	7.85	1000	290	86.4/57.6	3 at 28.8	12	Submrgd	Aboveground, aluminum	PDM	Air Products & Chemicals, Inc.	MCR	1972
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY Vancouver, B.C.	2.5	625	180	150/100	3 at 50	6	Submrgd	Aboveground, 9% nickel	Pittsburgh Des Moines Steel	Air Liquide	TEALARC	1971
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	5.68	625	175	100	2 at 50	4	Direct	Aboveground, 9% nickel	CBI	American Messer	Expander	1968
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	—	1000	290	50	2 at 25	—	Direct	Aboveground, 9% nickel	CBI	—	—	1971 - second tank
CHATTANOOGA GAS CO. Chattanooga, Tenn.	10.0	1200	348	125 90/60	2 at 62.5 2 at 62.5 3 at 30	20	Submrgd	Aboveground, 9% nickel	PDM	J. F. Pritchard	PRICO	1979
CITIZENS GAS & COKE UTILITY Beech Grove, Ind.	5.0	1000	290	180	3 at 60	5	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1972
COMMONWEALTH NATURAL GAS CO. Tidewater, Va.	5.0	1200	348	105	3 at 35	12	Direct	Aboveground, 9% nickel	PDM	Envirogenics	Cascade	1972
CONNECTICUT NATURAL GAS CORP. Rocky Hill, Conn.	6.6	1200	348	80/55	2 at 25	24	Vapor Trsf	Aboveground, 9% nickel	PDM	Arco Cryoplants	Expander/Nitrogen	1972
CONSOLIDATED EDISON CO. Astoria, N.Y.	6.0	1000	290	300/240	5 at 60	4	N.A.	Aboveground, 9% nickel	PDM	Arco Cryoplants	Expander/Nitrogen	1974
DELMARVA POWER & LT. CO. Wilmington, Del.	1.71	250	72.5	50	2 at 25	5	Direct	Aboveground, aluminum	CBI	Lotebro-Linde AG	Expander/Nitrogen	1972
EAST TENNESSEE NATURAL GAS CO. Fordtown, Tenn.	5.5	1200	348	150	2 at 75	8	Direct	Aboveground, aluminum	CBI	CBI	MRL	1975
ENERGY TERMINAL SERVICES CORP. Staten Island, N.Y. (Conversion of part of terminal capacity to peakshaving. Uses one of two storage tanks and all of vaporization capacity.)	15.0	3000	900	360	4 at 90	8	Direct	Prestressed concrete	Preload/Walsh	NA	NA	1982 planned
FALL RIVER GAS CO. Fall River, Mass.	0.5	150	45	10	1	15	Direct	Aboveground, 9% nickel	PDM	CVI Corp.	Dual J. T. Cycle	1970
GAS LIGHT CO. OF COLUMBUS Columbus, Ga.	1.7	500	145	60	2 at 30	8	Indirect	Aboveground, aluminum	CBI	CBI	Expander	1974
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	10.0	1000	290	180	3 at 60	16	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1969
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	—	1000	290	—	—	—	—	Aboveground, 9% nickel	Horton (CBI)	—	—	1972 - second tank
INTERMOUNTAIN GAS CO. Boise, Idaho	4.0	600	175	90/60	3 at 30	10	Submrgd	Aboveground, aluminum	PDM	Lotebro-Linde AG	Expander/Nitrogen	1974
IOWA-ILLINOIS GAS & ELEC. CO. Bettendorf, Iowa	2.0	500	145	50	2 at 25	10	Uniflux	Aboveground, aluminum	CBI	CBI	MRL	1972
IOWA POWER & LT. CO. Des Moines, Iowa	2.0	400	116	30	2 at 15	13	Intermed	Aboveground, aluminum	CBI	CBI	MRL	1975
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	2.5	400	117	30	2 at 15	26	Intermed	Aboveground, aluminum	PDM	APCO (prime) Air Liquide (liquefaction)	TEALARC	1976
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	—	400	117	—	—	—	—	Aboveground, aluminum	CBI	—	—	1978 - second tank
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.3	400	116	30/15	2 at 15	26	Direct	Aboveground, aluminum	CBI	CBI	MRL	1973
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.25	—	—	—	—	—	—	(Second liquefaction unit)	CBI	—	—	1974
LONG ISLAND LIGHTING CO. Holbrook, N.Y.	3.0	600	175	200/150	4 at 50	4	Submrgd	Aboveground, 9% nickel	PDM	Lotebro-Linde AG	Cascade/Mixed Refrigerant	1971
LOWELL GAS CO. Lowell, Mass.	4.5	1000	290	70/70	2 at 30 1 at 10	16	Direct	Aboveground, 9% nickel	Graver/Envirogenics	Envirogenics	Expander	1969
MEMPHIS LIGHT, GAS & WATER DIV. Memphis, Tenn.	5.0	1000	290	201	3 at 67	5	Submrgd	Aboveground, 9% nickel	CBI	Air Liquide	Cascade	1967
METRO UTILITIES DISTRICT Omaha, Neb.	6.0	1000	290	60/30	2 at 30	33	Submrgd	Aboveground, 9% nickel	CBI	Lotebro-Linde AG	Expander/Nitrogen	1975
MINNESOTA GAS CO. Burnsville, Minn.	5.0	1000	290	80	2 at 40	12	Intermed	Aboveground, 9% nickel	CBI	CBI	MRL	1978
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Direct	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1974
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Submrgd	Aboveground	CBI	Lotebro	Mixed Refrigerant	1980 - second facility - U.C.
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	2.5	625	180	85	3 at 42.5	7	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1968
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	—	—	—	—	1 at 42.5	—	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Lotebro Engr	—	1977
NORTHERN NATURAL GAS CO. Wrenshall, Minn.	10.0	2165	630	200	2 at 100	10	Submrgd	Aboveground, 9% nickel	PDM	SD Plants	TEALARC	1975
NORTHERN NATURAL GAS CO. Ventura, Iowa	14.5	2165	630	300	3 at 100	7	Submrgd	Aboveground, 9% nickel	PDM	NGG	PRICO	1978
NORTHERN STATES POWER CO. Eau Claire, Wisc.	2.0	270	78	24/24	2 at 12	11	Direct	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHERN STATES POWER CO. Wescott, Minn.	10.0	2000	580	75	2 at 37.5	28	Direct	Aboveground, 9% nickel	CBI	CBI	MRL	1975
NORTHWEST NATURAL GAS CO. Portland, Ore.	2.5	625	175	200	2 at 60 1 at 20	10	Direct	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHWEST NATURAL GAS CO. Newport, Ore.	5.0	1200	348	100/100	2 at 50	12	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL/CRYEX	1977
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	225	3 at 75	8	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1975
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	75	1 at 75	15	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1979
PEOPLES GAS, LIGHT & COKE Fisher, Ill.	10.0	2000	580	300/200 (2 x 290)	3 at 67 1 at 100	10	Direct	Aboveground, aluminum	CBI	CBI	Expander	1972
PHILADELPHIA ELECTRIC CO. West Conshohocken, Pa.	6.6	1200	348	310/186	5 at 62	4	Submrgd	Aboveground, 9% nickel	CBI	Arco Cryoplants	Expander/Nitrogen	1972
PHILADELPHIA GAS WORKS Philadelphia, Pa.	25.0	4000	1166 (2 x 583)	500/400	5 at 100	10	Intermed	Prestressed concrete	Preload	J. F. Pritchard	Cascade	1969 - Plant operable; 1974 on tanks
PIEDMONT NATURAL GAS CO. Charlotte, N. Car.	5.0	1000	290	150	3 at 50	7	Direct	Aboveground, 9% nickel	CBI	CBI	MRL	1973

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U.S. and Canadian LNG Peakshaving Facilities

November 1979

Company and Plant Site	Liquefaction Plant Capacity, MMcf/day	Storage Capacity, MMbbl	Regasification - MMcf/d				Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
			Total Design Capacity	Runs	No. of Days	Type					
PUBLIC SERVICE CO. OF NORTH CAROLINA, Cary, N. Car.	3.0	1000	290	100	2 at 50	Inter	Aboveground, 9% nickel	CBI	CBI	MRL	1976
ROANOKE GAS CO., Roanoke, Va.	1.0	200	58.5	20	2 at 10	Fluid	Aboveground, aluminum	CBI	CBI	MRL	1972
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 1 Plant	2.0	625	175	120/60	2 at 60	10	Submrgd	CBI	American Messer	Expander	1965
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 2 Plant	7.0	1200	348	180/120	3 at 60	10	Submrgd	CBI	Airco Cryopants	Expander/Nitrogen	1970
SOUTH CAROLINA LNG CO., Bushey Park, So. Car.	6.0	1000	290	60	2 at 30	17	Intermd	PDM	APCO (prime)	TEALARC	1976
SOUTHERN CONNECTICUT GAS CO., Milford, Conn.	6.6	1200	(2 x 145) 348	90	2 at 30	14	Vapor Trsf. Submrgd	PDM	Air Liquide	Expander/Nitrogen	1972
SOUTHWEST GAS CORP., Dayton, Nev.	5.0	1000	290	105/70	3 at 35	10	N.A.	CBI	CBI	MRL	1981—Planned
TENNESSEE NATURAL GAS LINES, INC., Nashville, Tenn.	5.0	1000	290	150/100	3 at 50	10	Direct Fired	CBI	CBI	MRL	1973
TEXAS EASTERN TRANS. CO., Staten Island, N.Y.	7.65	2000	600	292/195	3 at 97.5	10	Direct Fired	N.A.	Texas Eastern Cryogenics	TEALARC	1970; storage destroyed 1973; new double-wall tank—planned on same foundation
TRANSCANADA PIPELINES, Quebec City, Quebec, Canada	10.0	1000	300	125	NA	—	NA	NA	NA	NA	1983—Planned
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	7.0	1000	290	200/200	2 at 100	5	Intermd	CBI	J.F. Pritchard	Cascade	1965; 1970 on new tank
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	—	1000	290	200/200	2 at 100	—	Fluid	PDM	—	—	1974—second tank
UGI CORP., Temple, Pa.	2.0	250	73	30/30	3 at 10	8	Submrgd	PDM	Airco Cryopants	Expander	1973 (1977 as satellite)
UTILITIES BOARD, Trussville, Ala.	5.0	400	116	20	2 at 10	—	Intermd	CBI	CBI	MRL/CRYEX	1976
WISCONSIN NATURAL GAS CO., Oak Creek, Wisc.	0.75	256	72	50/25	2 at 25	10	Fluid	CBI	CBI	Cascade	1965

International LNG Peakshaving Facilities

Company and Plant Site	Liquefaction Plant Capacity, MMcf/day	Storage Capacity, MMbbl	Regasification - MMcf/d				Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
			Total Design Capacity	Runs	No. of Days	Type					
BRITISH GAS CORP., Avonmouth, Avon	10.0	1000	290	270	3 at 90	4	Submrgd	Whessoe, Ltd.	Cryopants, Ltd.	MCR	1978—Plant 1979—Tank
BRITISH GAS CORP., Avonmouth, Avon	—	1000	290	180	2 at 90	—	Submrgd	Motherwell Bridge Engr. Ltd.	—	—	1979—Second tank
BRITISH GAS CORP., Glenmavis, Scotland	5.0	1000	290	240	4 at 60	4	Submrgd	Motherwell Bridge Engr. Ltd.	Cryopants, Ltd.	MCR	1979—(North Sea Gas)
BRITISH GAS CORP., Glenmavis, Scotland	10.0	1000	290	120	2 at 60	17	Submrgd	Motherwell Bridge Engr. Ltd.	Cryopants, Ltd.	MRC	1975
BRITISH GAS CORP., Partington, Cheshire, England	10.0	2000	580 (2 x 290)	450	5 at 90	4	Submrgd	Wm. Neill & Son (St. Helens) Ltd. (PDM Lic.)	Cryopants, Ltd.	MRC	1973
BRITISH GAS CORP., Partington, Cheshire, England	10.0	2000	580 (2 x 290)	270	3 at 90	2	Submrgd	Whessoe, Ltd.	Cryopants, Ltd.	MRC	1974 on tank 1975 on plant
BRITISH GAS CORP., Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Motherwell Bridge Engr. Ltd.	Petrocarbon Development Ltd.	Open/Expander	1980—Planned
BRITISH GAS CORP., Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Whessoe, Ltd.	Petrocarbon Development Ltd.	Open/Expander	1981—Planned
BRITISH GAS CORP., Dynevor Arms, S. Wales	10.0	1000	290	180	2 x 90	5	N.A.	N.A.	Snamprogetti	MCR	1983—Planned
BRITISH GAS CORP., Canvey Island, England	10.3	—	—	—	—	—	—	—	Air Products, Ltd.	APCI-MCR	1972
N.V. NEDERLANDSE GASUNIE, Maassvlakte, The Netherlands	12.4	2790	860 (2 x 430)	930	8 at 90	4	Submrgd	Nederhorst Steel	Linde A.G.	Expander/Nitrogen	1977
DISTRIGAZ, S.A., Zeebrugge, Belgium	12.3	2480	716 (2 x 358)	391	5	6	Submrgd	Bolwert/CMP/CBI	Linde A.G.	Expander	1978
STUTTGART CITY UTILITIES, Stuttgart, W. Germany	3.4	665	193	66	3	10	Submrgd	Linde A.G.	Linde A.G.	Open Mixed Refrigerant	1971—Peakshaving plant
THYSSÉN GAS GmbH, Dinsburg, Hamborn, W. Germany	2.1	550	145	135/90	3 at 45	5.5	Submrgd	CBI	CBI	MRL	1976
GAS & FUEL CORP. OF VICTORIA, Dandenong, Victoria, Australia	5.0	500	145	125	2 at 62.5	4	Submrgd	CBI Pty. Ltd.	Cryopants, Ltd.	MRC	1979—U.C.

EUROPEAN SATELLITE PEAKSHAVING FACILITIES

Company	Plant Location	LNG Source	Storage Volume MMbbl	Storage Volume MMbbl	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
British Gas Corp.	Ambergate, Derbyshire England	Imported LNG From Canvey Island	265	72	64	Field Erected aluminum	Whessoe, Ltd.	Whessoe, Ltd. (Helium Expander Reliquefaction)	1969
British Gas Corp.	Amiswch, Anglesey, Wales, U.K.	British Gas Corp. Glenmavis, Scotland	0.399	0.0117	0.360	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp. Wales Region	1975
British Gas Corp.	Stranraer, Wigtownshire, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	3.535	1.037	1.200	Shop fabricated, stainless steel	Cryopants, Ltd.	British Gas Corp. Scottish Region	1973
British Gas Corp.	Oban, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	3.434	1.007	0.480	Shop fabricated, 2 tanks, stainless steel, 1 tank, 9% nickel	Clark Chapman, Ltd. Air Procs. Ltd.	British Gas Corp. Scottish Region	1972
British Gas Corp.	Tohessay, Bate, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	4.545	1.332	1.200	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp. Scottish Region	1975
British Gas Corp.	Dunoon, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	6.060	1.777	1.920	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp. Scottish Region	1973
British Gas Corp.	Dingwall, Ross, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	1.768	0.518	0.360	Shop fabricated, stainless steel	Cryopants, Ltd.	British Gas Corp. Scottish Region	1974
British Gas Corp.	Camelstown, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	4.545	1.332	0.960	Shop fabricated, 2 tanks, 9% nickel, 1 tank, stainless steel	Air Products, Ltd. Cryopants, Ltd.	British Gas Corp. Scottish Region	1974
British Gas Corp.	Moffat, Dumfriesshire, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	1.763	1.763	0.350	Shop fabricated, stainless steel	Cryopants, Ltd.	British Gas Corp. Scottish Region	1975
Gaz de France	Nantes, Loire-Atlantique France	Gaz de France LeHavre, France	50.3	15.7	17.0	Field erected, 1 tank, 9% nickel 3145 bbl, 1 tank, concrete/invar, 12,579 bbl	Creusot—Loire Gas Transport	Gaz de France	1966
Gaz de France	Granville, Manche, France	Gaz de France Le Havre, France	11.1	3.5	35.3	Field erected, 9% nickel	Bignier-Smidt- Laurent	Gaz de France	1976
Gaz de France	Saint Malo, Ile et Viane, France	Gaz de France Le Havre, France	5.0	1.6	35.3	Shop fabricated, 9% nickel (2 tanks)	I Aure Liquide	Gaz de France	1975
Erdgas Sudbayer GmbH	Geretsried, W. Germany	Technische Werke der Stadt Stuttgart, W. Germany	2.1	0.629	1.7	Shop fabricated	Linde AG	Linde AG	1974

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EUROPEAN SATELLITE PEAKSHAVING FACILITIES

Company	Plant Location	LNG Source	Storage Volume MMcf	MMcf	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Technische Werke der Stadt Stuttgart	(Truck)	Technische Werke der Stadt Stuttgart, W. Germany	0.880	0.258	0.848	Truck transport	Linde AG and Aurepa	Technische Werke der Stadt Stuttgart	1976
Thyssengas GmbH	(Truck)	Thyssengas Duisberg-Hamborn W. Germany	0.645	0.189	0.848	Truck transport	Aurepa	Thyssengas	1977
Gas Figueras S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	4.385	1.26	0.056	Shop fabricated, stainless steel	Mecanica de la Pena	Erhan	1971
Gas Costa Brava S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	0.877	0.252	0.252	Shop fabricated, stainless steel	Maguinista Terrestre Maritima	British Oxygen	1977
Gas Terracense S.A.	Tarragona, Spain	ENAGAS Barcelona, Spain	1.315	0.378	0.112	Shop fabricated, stainless steel		Air Liquide Spain	1977
Sugreres Gres Catalan S.A.	Barcelona, Spain	ENAGAS Barcelona, Spain	5.262	1.512	0.196	Shop fabricated, stainless steel		Air Liquide Spain	1973
Colonia Guell S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	1.754	0.504	0.037	Shop fabricated, stainless steel	Maguinista Terrestre Maritima	British Oxygen	1977
Gas Celra S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	1.315	0.378	N.A.	Shop fabricated, stainless steel	N.A.	N.A.	1977
Termica Cubellas	Tarragona, Spain	ENAGAS Barcelona, Spain	0.438	0.126	0.009	Shop fabricated, stainless steel	Air Liquide Espanola	Air Liquide Espanola	1978

NA = Not Available

LNG Satellite Peakshaving Facilities Small Capacity Plants—Shop Builtup Components

Company	Plant Location	LNG Source	Storage Volume MMcf	MMcf	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Bay State Gas Co.	Marshfield, Mass.	Bay State, Distigas	9.0	110	10.0	Shop builtup cylinders	Process Eng.	Gas, Inc.	1971
City of Brownsville Gas Dept.	Brownsville, Tenn.	Memphis LG&W	0.5	6	10.0	Trailer shuttle	Ryan Industries	City of Brownsville Gas Dept.	1970
Cape Cod Gas Co.	South Yarmouth, Mass.	Lowell Gas Co.	5.2	63.5	0.6	Shop builtup cylinder	Process Eng.	Process Eng.	1970
Cape Cod Gas Co.	Wareham, Mass.	Lowell Gas Co.	9.0	110	2.9	Shop builtup cylinder	Process Eng.	Gas, Inc.	1974, 1978
Concord Natural Gas Corp.	Concord, N.H.	Bay State Gas Co.	4.5	55	4.8	Shop builtup cylinders	Process Eng.	Gas, Inc.	1974
Consumers Gas Co.	Arnprior, Ont., Can.	Gas Metropolitan	4.5	55	4.8	Shop builtup cylinders	Process Eng.	Gas, Inc.	1978
DeKalb-Cherokee Counties Gas District	Fort Payne, Ala.	Chattanooga Gas Co.	4.5	55	2.2	Shop builtup cylinders	LOX Equip.	Ladd Eng. Assoc.	1972
Elizabethtown Gas Co.	Hackettstown, N.J.	Transco	1.7	21	5.8	Shop builtup cylinder	Process Eng.	PDM	1971
Fitchburg Gas & Electric Light Gas Service Inc.	Westminster, Mass.	Lowell Gas Co.	4.5	55	5.0	Shop builtup cylinders	Process Eng.	Gas, Inc.	1974
Holyoke Gas Department	Nashua, N.H.	New England LNG	4.5	55	7.2	Shop builtup cylinders	Process Eng.	Gas, Inc.	1973
Lawrence Gas Co.	Holyoke, Mass.	Lowell Gas Co.	18.0	220	12.0	Shop builtup cylinders	Process Eng.	Gas, Inc.	1971
Lowell Gas Co.	Lawrence, Mass.	Lowell Gas Co.	12.3	150	16.0	Shop builtup cylinder	H. L. Johnson	Gas, Inc. and Smith & Norrington	1969, 1972
Lowell Gas Co.	Wilmington, Mass.	Lowell Gas Co.	2.5	30	12.0	Shop builtup cylinders	H. L. Johnson	Gas, Inc.	1971
Lowell Gas Co.	Westford, Mass.	Lowell Gas Co.	4.5	55	6.0	Shop builtup cylinder	Process Eng.	Gas, Inc.	1972, 1974
Manchester Gas Co.	Manchester, N.H.	New England LNG Co.	4.5	55	6.0	Shop builtup cylinders	Process Eng.	Process Eng.	1975
Middleboro Gas & Electric Dept.	Middleboro, Mass.	Lowell Gas Co.	2.5	30	5.0	Shop builtup cylinder	Process Eng.	Gas, Inc.	1970
Hartford Elec. Lt. Co.	Torrington, Conn.	Distigas & New England LNG Co.	4.5	55	3.0	Shop builtup cylinder	Ryan Industries	N.E. Utilities	1972
Hartford Elec. Lt. Co.	Stamford, Conn.	Distigas & New England LNG Co.	4.5	55	4.8	Shop builtup cylinders	Ryan Industries	N.E. Utilities	1972
Hartford Elec. Lt. Co.	Danbury, Conn.	Distigas & New England LNG Co.	9.0	110	3.6	Shop builtup cylinders	Ryan Industries	N.E. Utilities	1972
Connecticut Lt. & Power Co.	Montville, Conn.	Distigas & New England LNG Co.	4.5	55	2.2	Shop builtup cylinders	Process Eng.	Gas, Inc.	1972
Connecticut Lt. & Power Co.	Waterbury, Conn.	Distigas & New England LNG Co.	12.4	165	7.2	Shop builtup cylinders	Ryan Industries	N.E. Utilities	1972
Connecticut Lt. & Power Co.	Norwalk, Conn.	Distigas & New England LNG Co.	4.5	55	2.4	Shop builtup cylinders	Ryan Industries	Conn. L&P	1975
Northern Utilities Inc.	Lowiston, Me.	New England LNG Co.	12.4	165	7.2	Shop builtup cylinders	Process Eng.	Applied Engineering, Gas, Inc.	1971, 1975, 1977
City of Norwich (Conn.) Dept. of Public Utilities	Norwich, Conn.	New England LNG Co.	4.5	55	7.2	Shop builtup cylinders	Process Eng.	Gas, Inc.	1972
Piedmont Natural Gas Company	Lenoir, N.C.	American LNG Corp.	4.5	55	2.2	Shop builtup cylinders	Process Eng.	Process Eng.	1971
Savannah Public Utility Dept.	Savannah, Tenn.	Chattanooga Gas Co.	0.85	11	1.5	Trailer shuttle	Process Eng.	Process Eng.	1973
United Cities Gas Co.	Murfreesboro, Tenn.	Chattanooga Gas Co.	4.5	55	0.2	Shop builtup cylinders	Process Eng.	Process Eng.	1973
UGI Corporation	Hazleton, Pa.	UGI Corp.	0.85	11	2.0	Trailer shuttle	Process Eng.	Cosmodyne	1974
Westfield Gas Dept.	Westfield, Mass.	Lowell Gas Co.	9.0	110	12.0	Shop builtup cylinders	Process Eng.	Gas, Inc.	1971, 1974
Wisconsin Gas Co.	Rice Lake, Wis.	Northern States Power	18.0	220	7.2	Shop builtup cylinders	Process Eng.	Gas, Inc.	1974
Middle Tennessee Natural Gas Authority	Smithville, Tenn.	Memphis LG&W Div.	1.8	22	0.08	Trailer Shuttle	American LNG Co.	American LNG Co.	1975

LNG Satellite Peakshaving Facilities Large Capacity Plants—Field Constructed K.D. Components

Company	Plant Location	LNG Source	Storage Volume MMcf	MMcf	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Atlanta Gas Light Co.	Macon, Ga.	Southern Energy	1500	450.0	150.0	Aboveground, aluminum	CBI	Applied Engineering	1977
Austell Gas Dept.	Austell, Ga.	American LNG Corp.	80	23.3	20.0	Aboveground, aluminum sphere	CBI	CBI	1972
Bay State Gas Co.	Easton, Mass.	Distigas	800	225.0	35.0	Aboveground, aluminum	CBI	CBI	1972
Boston Gas Co.	Salem, Mass.	Boston Gas	1000	290.0	30.0	Aboveground, 9% nickel	PDM	PDM	1972
Cape Cod Gas Co.	South Yarmouth, Mass.	Lowell Gas Co.	175	51.5	20.0	Prestress concrete w/liner	Walsh Construction	Gas, Inc.	1971
Chicago Bridge & Iron Co.	Cordova, Ala.	American LNG Corp.	45	13.0	3.5	Aboveground, aluminum sphere	CBI	CBI	1975
Elizabethtown Gas Co.	Elizabeth, N.J.	Transco	150	45.0	30.0	Aboveground, aluminum	PDM	PDM	1971
Fort Hill Natural Gas Authority	Fort Hill, S.C.	American LNG Corp.	35	10.0	12.0	Aboveground, aluminum sphere	CBI	CBI	1970
Haverhill Gas Co.	Haverhill, Mass.	Distigas	400	114.0	24.0	Aboveground, aluminum	CBI	CBI	1972

Cont'd LNG Satellite Peakshaving Facilities Large Capacity Plants—Field Constructed K.D. Components

Company	Plant Location	LNG Source	Storage Volume Mcf	Storage Volume Mcf	Sendout Capacity Mcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Lynchburg Gas Co.	Lynchburg, Va.	Roanoke Gas Co.	42	12.0	7.2	Aboveground, aluminum sphere	Graver	Gas, Inc.	1976
New Bedford Gas & Edison Light Co.	Acushnet, Mass.	Hopkinton LNG Corp.	200	58.0	30.0	Aboveground, 9% nickel	PDM	Air Products	1971
New Bedford Gas & Edison Light Co.	Acushnet, Mass.	Hopkinton LNG Corp.	300	87.0	—	Aboveground, aluminum	CBI	—	1973 (2nd tank)
New Jersey Natural Gas Co.	Stafford Township, N.J.	Distigas	100	28.5	20.0	Aboveground, aluminum	CBI	CBI	1971
New Jersey Natural Gas Co.	Howell Township, N.J.	Distigas	400	117.0	60.0	Aboveground, aluminum	PDM	PDM	1974
Northern States Power Co.	Wescott, Minn.	NSP, Eau Claire, Wis.	130	32.0	24.0	Aboveground, aluminum	CBI	CBI	1972
Northern States Power Co.	LaCrosse, Wis.	NSP	130	37.0	12.0	Aboveground, aluminum	CBI	CBI	1969
Philadelphia Gas Works	Philadelphia, Pa.	PGW	250	73.0	88.8	Aboveground, 9% nickel	PDM	Envirogenics	1971
Providence Gas Co.	Exeter, R.I.	Distigas	198	55.0	24.0	Aboveground, aluminum	Graver/ Envirogenics	Envirogenics	1972
Public Service Gas & Electric Co.	Burlington Township, N.J.	Distigas	350	100.0	75.0	In-ground, aluminum	CBI	Envirogenics	1972
Springfield Gas Utility	Springfield, Tenn.	Various	20	5.0	4.8	Aboveground, aluminum sphere	PDM	PDM	1974
South Jersey Gas Co.	McKee City, N.J.	Distigas	400	116.0	60.0	Aboveground, aluminum	CBI	CBI	1972
Valley Gas Co.	Cumberland, R.I.	New England LNG Co.	87	25.0	12.5	Prestressed concrete w/liner	LNG Co.	Gas, Inc.	1971

International Baseload LNG Liquefaction Facilities

Company and Plant Site	Liquefaction Plant Capacity, Mcf/day	Storage Capacity, Mcf	Storage Capacity, Mcf	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
ARCTIC PILOT PROJECT Bridgeport Inlet, Melville Island, Canada	275	NA	NA	NA	NA	NA	Precooled TEALARC	1983
CAMEL Arzew, Algeria	200.0 (Barge-mounted)	1840 total	210 (3x70) 310	Aboveground, (2-aluminum, 1-9% nickel)	CBI Inc.	TECHNIP	Cascade	1963 at sea, LNG for export to England, France
SONATRACH (LNG-1) Arzew, Algeria	1100.0	7000	1880 (3 x 630 tanks)	Aboveground, 9% nickel	Pritchard Toyo Kanetsu K. K. (PDM Lic.)	Pritchard Bechtel Corp. & Chemico	APCI-MCR	1978
SONATRACH (LNG-2) Arzew, Algeria	1000	6000	1800	Aboveground, 9% nickel	Toyo Kanetsu K. K. (PDM Lic.)	Pulman Kellogg	APCI-MCR	1980—U.C.
SONATRACH (LNG-3) Arzew, Algeria	1800	NA	NA	Aboveground	NA	Foster-Wheeler	TEALARC	1982—U.C.
SONATRACH—Phase I Skikda, Algeria	430.0 (3 trains)	2500	700 (2 x 350)	Aboveground, 9% nickel	CMP/CBI	TECHNIP	TEALARC	1972—export to France
SONATRACH—Phase II Skikda, Algeria	170.0 (1 train)	1250	350	Aboveground, 9% nickel	CBI	Pulman- Kellogg	PRICO	1979
SONATRACH—Phase III Skikda, Algeria	350.0 (2 trains)	3500	880 (2 x 440)	Aboveground, 9% nickel	CBI/Whessoe	Pulman- Kellogg	PRICO	1979—U.C.
ESSO LIBYA Marsa el Brega, Libya	385.0	2100	630 (2 x 315)	Aboveground, 9% nickel	CBI	Esso R&E-Bechtel— SNAM Progetti	APCI-MCR	1970
BRUNEI LNG Lumut, Brunei, Borneo	750.0	4050	1121 (3 at 377)	Aboveground, 9% nickel	Toyo Kanetsu K. K. (PDM Lic.)	Japan Gasoline Co.—UOP	APCI-MCR	1973
ABU DHABI GAS LIQUEFACTION CO. LTD., Das Island, Abu Dhabi	350.0	9600	1920 (2 x 960)	Aboveground, 9% nickel	I.H.I.	Bechtel-Chiyoda	APCI-MCR	1977
PHILIPS-MARATHON Kenai, Alaska	150.0	2300	675 (3 at 225)	Aboveground, aluminum	CBI	Phillips-Bechtel	Cascade	1969
PACIFIC ALASKA LNG CO. Cook Inlet, Alaska	400.0	3000	1100 (2 x 550)	Aboveground, 9% nickel	CBI	Fluor Corp.	APCI-MCR	1982—Planned
PETAMINA/MOBIL Arun, N. Sumatra, Indonesia	1200	8350	3200 (4 x 800)	Aboveground, 9% nickel	Toyo Kanetsu K. K. (PDM Lic.)	Bechtel, Inc.	APCI-MCR	1978
PETAMINA/HUFCO Badak, E. Kalimantan, Indonesia	550	8330	2400 (4 x 600)	Aboveground, 9% nickel	Hitachi Zosen—CBI	Bechtel, Inc.	APCI-MCR	1977
GAS DE CHILE (ENAP) Cabo Negro, Chile	250	NA	NA	NA	NA	APCI	APCI-MCR	1984—Planned
EL PASO ALASKA, INC. Point Barrow, AK	3375 (8 trains)	6000	2200 (4 x 550)	Aboveground, 9% nickel	NA	Phillips Petroleum	"Optimized" cascade	1980—Planned
PETRONAS/MITSUBISHI/ROYAL DUTCH-SHELL Bintulu, Sarawak, Malaysia	850	NA	NA	Aboveground	NA	NA	NA	1981—Planned
BONNY LNG Bonny, Nigeria	2000	(nominal)	NA	NA	NA	Phillips	"Optimized" cascade	1980 s—Planned
NATIONAL IRANIAN GAS CO. Kangan, Iran	400	6000	1800 (3 tanks)	Aboveground, 9% nickel	NA	NA	APCI-MCR	1983—Planned
NATIONAL IRANIAN GAS CO. Kangan, Iran	400 (Barge-mounted)	3580	1038	Barge-mounted, aluminum spheres	Moss-Rosenberg Vert	NA	APCI-MCR	1983—Planned
NATIONAL IRANIAN GAS CO. / FORMER KALINGAS ASSOCIATES Kangan, Iran	400	NA	NA	NA	NA	NA	NA	1980 s—Planned
WOODSIDE LNG PTY. LTD. Winfield Bay, Western Australia	900	NA	NA	NA	NA	NA	NA	1985

LNG Satellite Facilities in Japan

Company	Plant Location	LNG Source	Storage Volume Mcf	Storage Volume Mcf	Sendout Capacity Mcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Tokyo Gas Co.	Hitachi, Ibaragi	Tokyo Gas Co. Negishi/Sodegaura	31.3	9.20 (1x8.82) (1x0.38)	153 2 x 22 1 x 66	Field erected Shop fabricated	Hitachi Nippon Oxygen	Tokyo Gas Company	1970
Washinomiya Gas Co.	Washinomiya, Saitama	Tokyo Gas Co. Negishi/Sodegaura	0.77	0.226 (2x0.113)	33 3 x 11	Shop fabricated	Toyo Oxygen Nippon	Tokyo Gas Company	1971
Shioei Gas Co.	Higashimatsuyama Saitama	Tokyo Gas Co. Negishi/Sodegaura	0.43	0.126 (2x0.063)	10 2 x 5	Shop fabricated	Oxygen Nippon	Tokyo Gas Company	1975
Miho Gas Co.	Miho, Ibaragi	Tokyo Gas Co. Negishi/Sodegaura	1.29	0.378 (3x0.126)	66 3 x 22	Shop fabricated	Oxygen Nippon	Tokyo Gas Company	1977

U.S. Remote Supply Projects

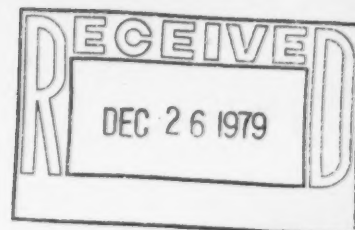
Company	Plant Location	Origin of Liquid	Site Storage, M gal	Site Vaporization, Mcf/hr
San Diego Gas & Electric Co.	Borrego Springs, Calif.	Peakshaving facility at Chula Vista, Calif.	7.75	9
San Diego Gas & Electric Co.	Alpine Village, Calif.	Peakshaving facility at Chula Vista, Calif.	25	30
San Diego Gas & Electric Co.	Camp Pendleton, Calif.	Peakshaving facility at Chula Vista, Calif.	50	90

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**DISTRIBUTION PIPING FORECAST
PLASTIC PIPE SURVEY**

PIPELINE & GAS JOURNAL

International Pipeline & Gas Utility Design, Construction & Operation

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in this issue

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THE COVER

Wisconsin Gas Company distribution crew member cuts ditch for new gas main representative of the growth during 1979 of the nation's gas distribution business.

—Photo Courtesy
Wisconsin Gas Company

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Gas Distribution Forecast



—Photo courtesy Wisconsin Gas Co.

Record \$1.704-billion expenditure forecast for 1980 for the gas distribution utilities will involve both new main and service construction, and a large amount of replacement work on both mains and services, as typified by this Wisconsin Gas Co. crew busy replacing a main section.

Gas Utilities See \$1.7 Billion Year

by Dean Hale, Editor

Gas distribution utilities added new customers in 1979 — almost with a vengeance — as demands for gas to replace costly oil and electric heating rose in the northern and northeastern states. As a result, 1980 is expected to be a record year.

In terms of expenditures, PIPELINE & GAS JOURNAL's 14th annual survey of gas distribution utilities projects \$1.704-billion for new and replacement mains and services and for system maintenance in 1980.

That figure is 9.3% above the record \$1.558-billion spent during 1979 for new and replacement mains and services and system maintenance — and 1979 represented an increase of 13.8% over 1978 expenditures.

The record dollar expenditure forecast for 1980 is result of two major factors: 1) more people want gas, and the required extensions will cost more money; 2) inflation takes its toll in increased material and labor costs that the gas utilities must pay to advance service to new areas and new customers.

And, as noted in previous years' surveys, the nation's burgeoning bureaucracy hasn't declined in size or impact, and all those federal, state, and local regulations likewise take a monetary toll.

With restrictions removed on customer additions in nearly all areas of the nation, and with gas supplies improving almost daily, the gas distribution industry expects to install 26,971 miles of new and replacement mains and services by year's end (and will have spent \$1,005,407,200 to do it — an increase of 13.8% above 1978 expenditures).

System maintenance expenditures continue to climb —

up 14%, with gas utilities spending a total \$553,183,380 in that area of operations.

More than 810,000 new customers are expected to be added to the rolls by the end of the year, an increase of 35% over the number added in 1978. Total number of customers expected to be served on December 31, 1979, is more than 46,000,000.

Gas utilities expect to add another 700,000 or more customers during 1980, provided the economy doesn't collapse completely and a relatively high level of housing starts persist. Despite high costs, it appears that new housing is widely sought and that economical natural gas is the preferred home-heating, cooking, and water-heating fuel. As noted earlier, there is strong demand in many areas of the country for gas service to replace increasingly expensive oil heat or electric heat.

Projections for 1980, based on returns to P&GJ's survey, show that 27,246 miles of new piping — including 13,448 miles of new and replacement mains and 13,798 miles of new and replacement services — will be installed.

Expenditures for new and replacement mains and services in 1980 are forecast to be \$1,126,107,400, while outlays for system maintenance will be \$578,526,600. (All projections are in 1979 dollars.)

Data for projections on 1979 and 1980 expenditures and pipe mileage were compiled in a survey of 500 leading gas utilities in 50 states. Responses on expenditures, planned installations, and operating and engineering conditions were supplied by utility management, engineering, and operating personnel.

Supply Seldom A Problem

Because supply in recent years has restricted orderly gas distribution utility development, and improved supply conditions during 1979 appeared to be stimulating industry growth in a measurable fashion, PIPELINE & GAS JOURNAL's 14th annual survey asked respondents to comment on gas supply conditions and customer attachment policies. The responses included:

"We continue to add customers without regard to supply. No problems."

"With greater supplies, we have restrictions on very large customers only."

"We now have an aggressive sales campaign to attract new heating customers through conversions and we are attaching hot water-heating loads."

"Our gas supply is more than adequate to meet our immediate needs."

"Began, as of February 1, 1979, taking on heating-only customers. As of March 1, 1979, all customers have to pay for service lines."

"No large industrial loads are being connected."

"Began attaching residential customers and commercial and industrial non-boiler loads in February, after a 2½-year period of no growth."

"Have been able to eliminate applicant waiting lists for residential space heating and small commercial users."

Gas Distribution Utility Expenditures

	Expenditures	
	1979	1980
New and replacement		
mains and service lines . . .	\$1,005,407,200	\$1,126,107,400
Maintenance of system . . .	553,183,380	578,526,600
TOTALS	\$1,558,590,580	\$1,704,634,000

Gas Distribution Utilities Pipe Installed

	Piping Installed, Miles		
	1978	1979	1980
Gas mains	10,233	13,319	13,448
Gas service lines	11,555	13,652	13,798
TOTALS	21,788	26,971	27,246

Gas Distribution Utilities— Pipe Installed—Total "In Ground"

Gas Mains	806,625
Gas Service Lines	498,034
TOTAL	1,304,659

"No restrictions. Have more gas allotted than we can sell."

"No change in customer attachment policies. We have always had plenty of gas."

"Service is available to all customers under 5 Mcf rating under our extension rule."

"Large industries that could use alternative fuels such as coal have done so. Others that could not have changed to firm contracts."

"Conservation has permitted attachment of more new residential customers."

"Thanks to customer conservation measures and loss of certain large industrial boiler loads, gas is now available for residential and light commercial usage. These customers are being attached without reservations at this time."

More Construction, Maintenance Expected

Survey respondents were also asked to comment on changes in construction and maintenance programs resulting from changes in gas supply and expanded marketing programs. Responses included:

"1980 appears to be an 'up' year — we'll add more customers in both 1980 and 1981."

"More construction was experienced in 1979, and 1980 will be even more active."

"Anticipate more business, therefore more construction-budget dollars. No change in maintenance program."

"Expanded construction program forced us to buy more equipment and more materials."

"New construction is down slightly, but we have greatly increased maintenance programs because men and equipment are available."

"No major changes in our programs."

"Increased programs in 1979 and 1980. Maintenance program right on schedule."

"We are well over budget in 1979."

"We anticipate a 300% increase in new gas customers."

"Our company has experienced a materials and manpower shortage as result of rapid increase of new-business requests. Maintenance program has suffered slightly for the same reasons. Hopefully, the 1980 year will bring better material supplies and more available manpower."

"Overall, new construction has tripled."

"Dramatic increase in 1979 new construction due to our strong gas supply situation. Rise in cost of home heating oil has helped us. We expect this high activity level to continue through 1980."

"Far more inquiries and applications for service than ever anticipated."

"Construction programs have increased significantly."

P&GJ

Plastic Pipe Revolution

Plastic pipe — especially polyethylene pipe — now dominates the new and replacement gas piping market. For the sixth year in a row, plastic pipe accounts for more than half of all pipe used by gas distribution utilities.

During 1979, plastic pipe accounts for 69.8% of all piping material used, according to PIPELINE & GAS JOURNAL's annual gas distribution piping survey.

Tabulated responses show that the industry will install 99,491,049 ft (18,843 miles) of plastic pipe and tubing of all sizes and types by the end of 1979. In terms of footage, it is the best year ever for plastic pipe.

For 1980, projected plastic pipe mileage is 21,260 miles — approximately 78% of the 27,246 miles of new and replacement mains and services foreseen to be installed during the coming year.

Total plastic pipe mileage installed by U.S. gas distribution utilities is now 154,276 miles. Latest records show that 925 gas utilities are using plastic pipe of some type. Of that number, 65 are considered major users, having more than 750,000 ft of plastic pipe installed.

Of all piping installed for the utility delivery of gas, plastic pipe now represents 12.08%.

Plastic pipe usage, expressed as a percentage of all gas distribution piping installed each year, continues to increase:

- 1966 ... 12.0% was plastic
- 1967 ... 13.5% was plastic
- 1968 ... 16.5% was plastic
- 1969 ... 19.0% was plastic
- 1970 ... 21.2% was plastic
- 1971 ... 24.9% was plastic
- 1972 ... 31.3% was plastic
- 1973 ... 42.2% was plastic
- 1974 ... 50.6% was plastic
- 1975 ... 55.8% was plastic
- 1976 ... 54.5% was plastic
- 1977 ... 72.2% was plastic
- 1978 ... 66.9% was plastic
- 1979 ... 69.8% was plastic
- 1980 ... 78.0% projected to be plastic.

Usage Trends

Plastic pipe for new and replacement mains represented 46.1% of the total amount of plastic pipe installed in 1979. Plastic pipe used for new and replacement services represented 53.8% of the total for 1979. Only 0.1% was used for other applications — gas lights, gas grills, regulator vault vents, and cathodic protection test stations.

Of the companies reporting use of plastic materials, 88.1% are using plastic pipe for new and replacement mains, and 90.7% are using plastic for new and replacement services.

Polyethylene dominates the market. Polyethylene — grades 2306, 3306, or 3406 — is used by 95.1% of all companies installing plastic pipe today. P&GJ's survey concludes that 71.8% use PE 2306, 36.9% use PE 3306 or PE 3406, 5.8% use PVC, 1.9% use polybutylene, and 0.9% use ERF. No other types appear to be in use today.

Of the grand totals of piping installed, as compiled from survey responses, 46.9% of the plastic piping now in use is 1-in. and under in size, 41.5% is in the 1¼-in.-to-2-in. range, 7.5% is 3-in., 3.4% is 4-in., and 0.7% is larger than 4-in.

Plastic Brings Changes

P&GJ's 1979 survey of plastic piping asked users if they were using more plastic pipe and how use of plastic had changed procedures and equipment requirements for con-

**Sizes of Plastic Installed (% of Total)
by Gas Distribution Utilities**

Size (Inches)	% Total 1978	% Total 1979	% Total 1980
½ and under	53.0	55.1	51.6
1 to 2	34.3	36.3	40.1
3	3.6	3.6	3.4
4	4.3	4.2	4.2
6 and over	0.8	0.8	0.7

Keeps Growing

by Dean Hale, *Editor*

struction/maintenance/repair. Here are some typical answers:

"Plastic pipe allows for less bulky, lighter, and 'hopefully' less-expensive equipment to handle material."

"We have used only plastic pipe since 1968, and our procedures stay much the same. Some more advanced equipment has been added from time to time."

"We plan to use more plastic pipe in the future."

"Have used plastic pipe from 1960 to date."

"Use plastic principally for insert renewals."

"Plastic is our primary distribution material. We standardized on plastic pipe in 1968."

"Use plastic for 95% of our new piping and 85% of our replacement piping. Butt-fusion has been approved and will require new equipment."

"We are going to PE 3406 as PVC is no longer available."

"Have been using plastic pipe for 95% of all new mains and service installations for over 10 years."

"We are using more plastic pipe, but it has no effect on our procedures or equipment requirements, as we use outside contractors exclusively."

"About 90% of pipe installed is plastic. It requires less heavy equipment but increasing amounts of procedural training."

"Using more plastic. Repairing more dig-ins. We are equipping our crews for plastic construction and repair of

plastic lines. Have big problem keeping our weldors on steel qualified because of not-enough steel construction."

"Use more plastic. In many ways has reduced equipment requirements."

"Recently we began using 6-in. plastic pipe — it requires new and larger fusion equipment, and we are also introducing fusion techniques to service men who will soon be performing jobs that were previously handled by construction crews."

"We are now able to use smaller crews due to lesser weight of plastic (vs. steel), plus a weldor is not required."

"All new piping 3-in. and under is plastic, and use of plastic has increased our ability to do a portion of our own construction."

"No significant change in procedures or equipment requirements even though we have increased number of extensions to serve new customers."

"Utilizing plows to greater extent for service installations with more emphasis on plastic joining tools and on training and equipment."

"Bought all new tools and equipment for plastic, including tools for squeeze-off for repairs and tie-ins."

"Our conversion to plastic required substantial changes in procedures and equipment."

"We are expanding the use of plastic pipe in large sizes. All of our vehicles are equipped to handle plastic installations for new construction or repairs."

"More plastic is being used now, and this trend should continue to increase."

"Have been about 80% plastic for the past five to seven years. Major change has been from socket to butt-fusion a few years ago."

"We are going to an all-plastic system, up to 4-in; training and equipment requirements are gearing up for it."

"Use of plastic has reduced crew size — four-man crews to two or three men, and that has allowed change in basic, crew truck cab and chassis from expensive tilt-cab model to conventional cab."

1979 Gas Distribution Utility Usage of Plastic Pipe

Type of Installation	% of Total
New Mains	22.8
Replacement Mains	23.3
New Services	28.8
Replacement Services	25.0
Other Applications (gas lights, grills, etc.)	0.1

Profit Margins Edge Up

by Julie Fonner, Assistant Editor

Increased production of oil and natural gas in the United States — and all over the world — accounted for many oil/gas companies' earnings increases for the third quarter of 1979.

Our survey of oil companies' third quarter results shows an increase in profit margin to 6.0% from 4.5% in the 1978 quarter. Return on revenues for the nine months is 6.0%, up from 4.5% in 1978.

Superior Oil, nation's largest producing oil/gas company having no refining or marketing operations, said increased production and higher prices contributed to its profits increase over the 1978 third quarter.

Crystal Oil, Noble Affiliates, Belco Petroleum, Crestmont Oil & Gas, Mesa, Natomas and Southland Royalty all said higher prices for oil and gas and increased production resulted in earnings increases.

North Slope production is increasing for Atlantic Richfield,

and with improved wellhead prices allowed by government, ARCO reported increased earnings for the 1979 third quarter. Worldwide profits on products sold were 1.6¢ per gallon.

Sohio's Alaskan operations contributed biggest share to their earnings. Coal operations "continue to suffer from operating and productivity problems."

Cities Service said nine-months earnings rise resulted from oil/gas production, natural gas liquids, refining, marketing and minerals operations.

Diamond Shamrock and Quaker State reported improved earnings in coal operations. Conoco's coal earnings declined.

Conoco's 134% increase in earnings for the third quarter over 1978 can be "attributed almost entirely to foreign petroleum operations." Conoco's profit on a gallon of refined products sold was 1¢ per gallon, the same as in the 1978 period. Conoco's 134% increase in earnings means a return of 7.1%.

Mobil reports an increase in profits on products sold from 2.1¢ per gallon in 1978 to 3.4¢ per gallon worldwide.

Standard California's profits on products sold worldwide were 2.9¢ per gallon in 1979 nine months; profits on U.S. sales were 2.5¢/gal.

Gulf says two-thirds of its earnings increase occurred in foreign operations. A 97% increase in profits for the third quarter reflects return on revenues of 6.2¢/\$1 of revenues in 1979 compared to 4.2¢/\$1 revenues in 1978 third quarter.

Gas utility company return on revenues for 12 months ending September 30 was 5.5% compared to 6.1% in 1978 period.

Alabama-Tennessee Natural Gas' earnings increase because of more gas supplies ... United Energy Resources said improved supplies helped their earnings also.

El Paso attributes earnings rises to "continued buildup of LNG deliveries" to the U.S. East Coast, natural gas operations and chemical subsidiary improvements.

THIRD QUARTER NATURAL GAS COMPANIES FINANCIAL REPORTS

Company	Three months ending September 30**				Twelve months ending September 30**				Profit					
	Revenues (\$000)		Earnings* (\$000)		Revenues (\$000)		Earnings* (\$000)		Margin*					
	1979	1978 % Chg.	1979	1978 % Chg.	1979	1978 % Chg.	1979	1978 % Chg.	1979	1978				
Alabama Tennessee N.G.	20,136	9,517	+111.6	1,446	1,074	+34.6	58,031	37,120	+56.3	4,346	2,956	+47.0	7.5	8.0
Alberta Gas Trunk Lines							767,970 ¹	346,039 ¹	+121.9	78,692 ¹	56,336 ¹	+39.7	10.2	16.3
American Natural Resources	482,676	386,813	+24.8	(13,462)	(154)	-8641.6	2,337,446	2,030,888	+15.1	99,922	143,083	-30.2	4.3	7.1
Arkansas Louisiana Gas	178,430	109,563	+62.9	11,260	6,267	+79.7	663,843	519,998	+27.7	61,583	53,027	+16.1	9.3	10.2
Coastal States Gas	1,339	908	+47.5	30	11	+172.7	3,836 ¹	2,855 ¹	+34.4	85 ¹	42 ¹	+102.4	2.2	1.5
Columbia Gas	455,584	373,515	+22.0	(2,858)	(2,909)	+1.8	2,642,456	2,407,822	+9.7	137,838	129,652	+6.3	5.2	5.4
Commonwealth Nat. Res.	31,094	21,672	+43.5	606	62	+877.4	139,409	117,960	+18.2	4,825	3,470	+39.0	3.5	2.9
Consolidated Nat. Gas	303,598	203,498	+49.2	(995)	(1,024)	+2.8	1,850,898	1,545,210	+19.8	110,118	98,748	+11.5	6.1	6.4
El Paso Company	835,955	516,869	+61.7	38,497	24,003	+60.4	2,187,821 ¹	1,449,246 ¹	+51.0	110,419 ¹	71,527 ¹	+54.4	5.0	4.9
Enserch Corp.	572,387	403,203	+42.0	18,990	8,830	+115.1	1,640,417 ¹	1,289,659 ¹	+27.2	73,372 ¹	58,284 ¹	+25.9	4.5	4.5
Equitable Gas							256,724	210,550	+21.9	23,786	15,055	+58.0	9.3	7.2
Houston Nat. Gas ²							1,797,835	1,554,002	+15.7	138,108	130,047	+6.2	7.7	8.4
Kansas Nebraska Nat. Gas	78,337	73,209	+7.0	3,544	5,096	-30.5	308,889	271,941	+13.6	18,008	21,041	-14.4	5.8	7.7
Mountain Fuel Supply							314,158	270,802	+16.0	20,899	21,808	-4.2	6.7	8.1
Northern Nat. Gas	514,885	375,883	+37.0	20,116	13,229	+52.1	2,262,271	1,866,101	+21.2	172,896	138,136	+25.2	7.6	7.4
Northwest Energy	214,900	169,100	+27.1	7,800	2,500	+212.0	998,000	788,700	+26.5	36,800	19,400	+89.7	3.7	2.5
Oklahoma Nat. Gas	138,779	116,170	+19.5	3,797	6,275	-39.5	687,974	631,912	+8.9	31,196	39,275	-20.6	4.5	6.2
Pacific Lighting	527,073	423,336	+24.5	27,301	18,536	+47.3	2,016,462	1,688,065	+19.5	99,004	78,098	+26.8	4.9	4.6
Panhandle Eastern Peoples Gas	466,607	328,386	+42.1	39,209	19,456	+101.5								
							2,441,556	1,879,288	+29.9	140,288	130,363	+7.6	5.7	6.9
Pioneer Corp.	206,083	160,980	+36.5	20,134	8,540	+135.8	660,266	555,302	+18.9	53,295	37,181	+43.3	8.1	6.7
Southern Nat. Res.	350,735	241,938	+45.0	26,007	23,835	+9.1	1,367,032	1,047,522	+30.5	108,782	106,072	+2.6	8.0	10.1
Southern Union Co.	169,998	118,561	+43.4	4,065	437	+830.2	672,704	533,547	+26.1	26,338	20,052	+31.4	3.9	3.8
Texas Eastern Corp.	723,927	470,196	+54.0	39,027	24,919	+56.6	2,649,222	1,965,274	+34.8	165,324	130,158	+27.0	6.2	6.6
Texas Gas Trans.	401,177	282,682	+41.9	17,295	11,192	+54.5	1,532,142	1,152,475	+32.9	69,314	59,191	+17.1	4.5	5.1
TransCanada Pipelines	583,301	507,842	+14.9	21,826	21,642	+0.9	2,370,930	2,109,657	+12.4	80,200	83,395	-3.8	3.4	4.0
Transco Companies	373,701	233,253	+60.2	14,428	13,777	+4.7	1,366,612	898,086	+52.2	59,242	51,571	+14.9	4.3	5.7
Union Gas Ltd.	103,801	89,917	+15.4	2,117	1,887	+33.4	244,669 ³	207,554 ³	+17.9	6,105 ³	6,959 ³	-12.3	2.5	3.4
United Energy Res.	843,514	525,092	+60.6	33,691	22,506	+49.7	2,691,805	1,913,149	+40.7	100,260	80,703	+24.2	3.7	4.2
Westcoast Trans.							722,800 ¹	583,300 ¹	+23.9	36,900 ¹	33,600 ¹	+9.8	5.1	5.8
TOTALS	8,578,017	6,132,103	+39.9	333,871	229,687	+45.4	37,654,178	29,874,024	+26.0	2,067,945	1,819,230	+13.7	5.5	6.1

**Excluding non-recurring items. *Earnings available to common stock. *Earnings/Revenues ratio. (1)Loss. (2)Nine months. (3)Ends July 31. (4)Six months.

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THIRD QUARTER OIL COMPANIES FINANCIAL REPORTS

Company	Three months ending September 30**						Twelve months ending September 30**					
	Revenues (\$'000)	1978 % Chg.	1979	1978 % Chg.	1979	Profit Margin	Revenues (\$'000)	1978 % Chg.	1979	1978 % Chg.	1979	Profit Margin
Adams Res. & Energy	50,900	25,034+103.3	1,174	1,011 +16.1	2.3	4.0	94,123 ¹	44,649+110.6	1,759 ¹	1,114 +37.9	1.9	2.5
Adobe Oil	25,230	17,994+40.2	3,037	1,962 +54.8	12.0	10.9	63,460	52,624+20.6	7,709	5,626 +37.0	12.1	10.7
Amarex Inc. ³	3,975	2,819 +41.0	1,020	948 + 7.6	25.7	33.6						
Amara Hess	1,572,393	1,135,588+38.7	119,196	30,561+290.0	7.6	2.7	4,689,476	3,524,693+33.0	350,254	97,348+259.8	7.5	2.8
American Petroleum	427,817	299,643+42.8	37,883	4,905+672.3	8.9	1.6	1,129,678	845,178+33.7	65,480	11,550+147.5	5.8	1.4
American Qassar	8,140	6,408 +27.1	1,047	940 +11.4	12.9	14.7	21,956	19,487+12.7	1,528	1,116 +36.8	7.0	18.2
Arapaho Petroleum	1,021	508 +67.9	35	119+369.2	3.4	none	3,352	5,077+34.0	187	65 +187.7	5.6	1.3
Argonaut Energy	615	553 +74.2	(53)	(82)	none	none	1,254	1,254 +0.0	140	(283)	none	none
Argo Petroleum	2,131	1,774 +20.1	94	(76)+23.7	4.4	none	6,095	5,128 +18.8	229	(337)+168.0	5.8	none
Asamera Oil	64,627	41,887+54.3	3,439	1,027+234.9	5.3	2.5	119,041 ¹	83,409 ¹ +42.7	6,610 ¹	1,583 ¹ +15.2	5.6	1.9
Ashland Oil	1,966,342	1,509,837+30.2	63,429	64,766 - 2.1	3.2	4.3	5,255,452	4,116,547+27.7	127,339	111,096 +51.6	2.4	2.7
Atlantic Richfield	4,378,657	3,408,006+28.5	320,363	220,524 +45.3	7.3	6.5	11,627,060	9,168,738+22.8	822,936	581,751 +41.5	7.1	6.1
Beard Oil	3,536	2,265 +56.1	318	598 + 5.3	17.5	26.4	8,730	6,548 +33.3	1,059	1,575 +34.0	11.9	24.1
Belco Petroleum	185,807	112,278+65.3	22,930	11,289+103.1	12.3	10.1	441,057	323,640+36.3	54,116	34,870 +55.3	12.3	10.8
Brook Exploration	1,156	751 +56.6	231	119 +94.1	19.6	15.8	2,109	1,486 +47.4	468	463 + 1.1	21.4	31.2
Burges Gas & Oil	30,539	45,962+33.6	151	244 -38.1	0.5	0.5	102,824	120,175+14.7	1,134	492+130.5	1.1	0.4
C&K Petroleum	8,178	5,571 +46.8	1,142	533+114.3	14.0	9.6	21,315	15,608 +36.6	1,842	1,232 +49.5	8.6	7.9
Callon Petroleum ⁴	1,704	1,302 +30.9	373	318 +17.3	21.9	24.4						
Cities Service	1,601,600	1,124,000+42.5	86,100	52,600 +63.7	5.4	4.7	4,472,500	3,431,500+30.3	241,300	148,300 +62.7	5.4	4.3
Clark O&R	311,995	264,825+17.8	13,433	4,506+198.1	4.3	1.7	854,095	715,019+19.5	29,555	5,762+412.9	3.5	0.8
Commonwealth Oil	332,200	246,000+35.0	23,200	2,000+1060.0	7.0	0.8	889,300	695,800+27.8	71,300	(2,600)+284.3	8.0	none
Consolidated O&G	4,953	3,265 +51.7	1,049	(2,636)+139.8	21.2	none	24,152	19,036 +26.9	665	(345)+292.8	3.5	none
Conoco Inc.	3,448,709	2,450,700+40.7	247,100	105,800+133.6	7.1	4.4	9,287,000	7,042,100+31.9	624,700	296,000+111.0	6.7	4.2
Crestmont O&G	2,810	1,443 +94.7	982	356 +175.8	34.9	24.7	6,155	4,897 +25.7	2,004	1,070 +90.9	32.6	21.9
Crown Central	283,175	156,996+80.4	22,947	6,968 +229.3	8.1	4.4	730,773	451,257+61.9	52,233	1,990+647.3	7.1	1.5
Crystal Oil	46,099	26,141+76.2	3,158	(6,231)+606.9	6.9	none	111,313	75,090+48.2	6,737	(1,970)+442.0	6.1	none
Delhi International	5,025	4,221 +19.0	965	634 +52.2	19.2	15.0	12,275	8,415 +45.9	1,945	1,259 +54.5	15.8	15.0
Diamond Shamrock	617,629	465,330+32.7	37,122	29,592 +25.4	6.0	6.4	1,713,209	1,361,977+25.8	119,676	92,954 +28.7	7.0	6.8
Dorchester Gas ⁴	125,399	72,572+72.8	10,320	7,354 +40.3	8.2	10.1	368,267 ²	185,241+98.8	25,516 ²	15,031 ² +69.8	6.9	8.1
Dyco Petroleum	6,822	3,395+100.9	1,431	1,092 +31.0	21.0	32.2	15,835	8,392 +88.7	3,681	2,501 +47.2	23.2	29.8
Earth Resources ⁴	157,747	105,211+50.8	6,514	4,511 +44.4	4.7	4.3	313,405	291,885 +7.4	13,211	8,610 +53.4	4.2	2.9
Energy Minerals	2,650	1,509 +75.6	834	813 +26.1	31.7	40.6	6,158	4,808 +26.2	1,324	1,371 +3.4	21.5	28.5
Energy Reserves Gp.	28,005	18,878 +48.3	1,520	(719)+111.4	5.4	none	68,800	55,545 +23.5	5,807	1,054 +70.9	6.4	1.9
Equity Oil	2,982	3,327 +10.4	850	700 +21.4	28.5	21.0	8,433	8,346 +1.7	2,018	1,978 +2.0	23.9	22.4
Exeter Oil	632	416 +51.9	268	88 +204.3	42.4	21.2	1,474	1,199 +22.9	410	224 +83.0	27.8	18.7
Exxon	20,649,000	15,914,000+29.8	1,145,000	525,000+118.1	5.5	3.3	59,055,000	46,698,000+26.5	2,930,000	1,910,000 +53.4	5.0	4.1
Falcon	10,834	8,111 +33.6	2,252	1,486 +51.5	20.8	18.3	30,021	24,235 +23.9	6,524	4,769 +36.8	21.7	19.7
Forest Oil	17,328	15,268 +13.5	1,808	1,351 +40.5	11.0	8.8	31,365	32,590 - 3.8	4,873	6,646 +26.7	15.5	20.4
Galaxy Oil ⁴	1,903	1,442 +32.0	(50)	81 -61.8	none	5.6						
General American	51,552	34,192+50.0	11,252	6,410 +75.1	22.7	19.4	135,615	104,257 +30.1	30,964	19,123 +51.9	22.8	18.3
Getty	1,329,297	926,442+43.5	173,877	95,809 +81.4	4.1	4.9	5,574,213	2,724,933+31.2	421,033	237,672 +84.9	11.8	8.4
Great Basin ³	7,616	5,664 +34.5	155	592 - 73.8	2.0	10.5	26,042 ²	20,661+26.0	1,589 ²	2,489 -36.2	6.1	12.0
Gulf Energy & Devel.	14,780	4,538+225.7	1,387	415 +234.2	9.4	9.1	29,863	14,169+110.8	3,119	1,638 +90.4	10.4	11.6
Gulf Oil	6,736,000	5,048,000+33.4	416,000	211,000+97.2	6.2	4.2	18,410,000	14,648,000+25.7	956,000	548,000 +74.5	5.2	3.7
Hudson Ohio	1,949	1,120 +74.0	581	157 +270.1	29.8	14.0	4,509	3,557 +26.8	797	94 +19.8	17.7	27.9
Hamilton Brothers	33,461	28,001 +19.3	8,188	2,787 +194.1	24.5	10.9	91,520	51,865 +76.5	13,529	7,560 +83.8	14.8	14.2
Helmerich & Payne	41,833	35,373 +17.6	8,864	6,839 +29.6	21.2	19.2	116,741	95,555	24,963	19,954		
Hershey Oil	23	22 +45.5	23	126+188.5	3.7	none	1,462	1,247 +13.6	(234)	(207)	none	none
Holly Corp.	79,348	63,343 +25.3	1,527	2,104 +27.4	1.9	3.3	198,148	159,781 +24.0	4,808	5,277 +8.9	2.4	3.5
Houston O&M	91,112	76,457 +19.2	14,111	13,143 +7.4	15.5	17.2	249,108	242,916 +2.5	39,577	44,537 +11.1	15.9	18.3
Howell Oil	119,546	58,078+105.8	10,318	855+1106.8	6.6	1.5	242,568	152,130+59.4	20,712	2,148 +84.1	8.3	1.4
Husky Oil							672,700	528,800+26.2	42,509	39,100 +8.7	6.3	7.5
Inexco Oil	27,583	17,361 +58.9	4,534	2,038 +122.5	16.4	11.7	73,328	55,513 +32.1	12,132	8,123 +49.4	16.5	14.6
Juniper Petroleum	4,473	2,421 +84.5	543	19,275+7.9	12.1	0.4	11,164	8,045 +38.8	747	112 +56.7	0.7	1.4
KRM Petroleum	927	443+109.3	306	130+400.0	33.0	0.2	1,986	1,213 +63.0	380	(81)+450.9	1.1	none
Kerr-McGee Corp.	679,798	525,574+29.8	42,592	34,179 +24.6	6.3	6.5	1,927,999	1,528,301+26.1	119,621	78,171 +33.0	8.2	5.1
Lear Petroleum							78,314 ²	57,654+35.8	5,004 ²	3,242+54.2	6.4	5.6
Louisiana L&E	203,055	139,263 +45.8	37,691	23,074 +63.3	18.6	16.6	570,662	404,815 +41.0	124,711	72,575 +71.9	21.9	17.9
Mupco	210,508	95,572+120.3	16,539	4,705 +251.5	7.9	4.9	552,354	402,637+37.2	47,662	38,815 +23.3	8.7	9.6
Marathon	1,913,635	1,199,374+59.6	79,656	50,191 +57.8	4.2	3.4	4,979,235	3,582,250+39.0	268,961	151,302 +77.8	5.4	4.2
May Petroleum	3,549	1,502+136.3	147	73 +101.4	4.1	4.9	10,545	5,527 +89.8	999	627 +59.3	9.3	11.3
Maynard Oil ⁴	4,296	4,137 +3.8	321	334 - 3.9	7.5	8.1						
McCulloch Oil	29,930	24,146 +24.0	14,883	677+2098.4	49.6	2.8	77,404	67,219 +15.2	16,124	4,498 +258.5	20.8	6.7
McFarland Energy	2,533	1,471 +72.2	781	295 +164.7	30.8	20.1	6,128	4,618 +32.7	1,755	897 +95.1	28.6	19.4
McKinnon Oil & Gas	7,761	4,766 +59.1	676	536 +63.4	11.6	11.2						
Nessa Petroleum	69,250	39,232 +76.5	12,172	8,383 +45.2	12.6	21.4	181,921	120,863 +50.5	37,843	30,242 +25.1	20.9	25.0
Mitchell Energy	101,930	64,520 +58.0	11,411	8,716 +30.9	11.2	13.5	187,419 ¹	127,303 ¹ +47.2	20,022 ¹	17,473 ¹ +14.6	10.7	13.7
Mobil Corp.	12,383,016	9,107,000+35.0	594,098	258,276+130.0	4.8	2.8	33,451,158	26,649,764+25.5	1,435,542	792,315 +81.2	4.3	5.0
Murphy Oil	452,233	311,821 +45.0	28,625	10,949 +161.4	6.3	3.5	1,179,021	914,191 +29.0	63,960	29,207 +119.0	5.4	3.2
Natams	254,707	236,139 +7.9	32,671	18,679 +74.9	12.8	7.9	708,403	642,384 +10.3	75,129	52,708 +42.5	6.0	8.2
Noble Affiliates	34,736	46,209 +18.5	9,156	7,176 +27.6	16.7	15.5	151,896	129,016 +17.7	22,128	19,210 +15.2	14.6	14.9
Occidental Petr.	2,608,009	1,682,000+55.1	186,100	19,500 +864.2	7.1	1.1	6,688,200	4,489,500+49.0	374,800	(16,600)+2357.8	6.4	none
Ocean Oil & Gas	15,519	8,316 +86.6	2,856	1,167 +144.7	18.4	14.0	39,582	22,383 +76.8	5,824	2,019 +188.5	14.7	9.0
Onco	5,276	926+255.8	106	161 +34.4	7.4	14.4	7,814	7,230 +22.4	4,714	174 +121.4	4.7	7.8
Pacific Resources	158,178	124,747 +26.8	3,554	2,739 +29.8	2.2	2.2	381,753	338,324 +16.8	8,717	6,423 +55.5	2.5	1.9
Patrick Petroleum ³	8,411	5,428 +55.0	(691)	(403)	none	none	39,622 ²	20,572+92.6	1,695 ²	1,095 ² +44.8	4.3	5.3
Pennzoil Co.	511,966	392,768+32.9	61,164	30,725 +99.1	11.7	7.8	1,448,629	1,105,402+31.0	165,360	85,067 +94.4	11.4	7.7
Petroleum Development	2,160	4,273 +94.4	306	568 +46.1			6,506	9,339 +30.3	717	1,516 +71.2	11.0	16.2
Petro-Lewis Corp.	23,050	11,317+103.7	4,455	1,256 +254.7	19.3	11.1						
Phillips Petr.	2,496,051	1,751,131+42.5	193,027	118,797 +62.5	7.7	6.8	6,699,961	5,221,940+28.3	584,630	438,5		

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Vigorous Construction Year To Begin 1980's Decade

by Dean Hale, Editor

Pipeline projects planned, proposed, or underway in the United States now total 29,607 miles, according to PIPELINE & GAS JOURNAL's annual U.S. Pipeline Construction Survey, and 7268 miles of cross-country pipelines are expected to be installed during 1980 as mainlines and gathering systems.

The U.S. plus Canada total for planned, proposed, or underway projects is 40,451 miles. Projected miles of pipe to be installed in Canada are approximately 4000 miles of mainline and gathering lines (see related article this issue).

Altogether, that's over 11,000 miles of pipeline construction to be undertaken in the U.S. and Canada in the first year of the new decade, and a healthy boost for the economy in both nations as well as providing needed additions to transport new energy supplies.

In the U.S., of the overall total, 14,399 miles are natural gas transmission lines, 5075 are crude oil pipelines, 3168 are products pipelines, and 7965 miles are slurry pipeline projects.

Biggest news to the cross-country oil and gas pipeline business as the 1980's begin is that Canada's National Energy Board has approved new exports of 3.75 trillion cu ft of natural gas by 1987, an action that will permit pre-building of various U.S. and southern Canadian sections of the Alaska Highway Gas Pipeline Project and related lines.

NEB's approved quantities were higher than the two trillion cu ft that Canada had declared surplus in February 1979, but they are much lower than the 8.8 Tcf over 15 years that had been sought by 10 exporters and their U.S. customers.

Of the total approved, Pan-Alberta Gas Ltd. of Calgary will get 1.8 Tcf for sale to Northwest Alaskan Pipeline Co. The gas is to flow south through pre-build sections of the giant Alaskan gas project. NEB said initial flow should begin in November 1980 on the western leg of the pipeline and additional gas through an eastern leg in November 1981.

No construction is underway on either section and target dates might be impossible to achieve because regulatory proceedings haven't been completed in either Canada or in the U.S. Project sponsors in mid-1979 were planning on 280

miles of 36-in. in Canada and 160 miles of 36-in. loop on the Pacific Gas Transmission Co. system as pre-build for the western leg, and 395 miles of 42-in. in Canada and 809 miles of 42-in. (Northern Border Pipeline) in the U.S. for the eastern leg.

Outlook for pipeline construction in the United States is for 3260 miles of gas transmission pipelines, 1121 miles of crude oil pipelines, 1047 miles of products pipelines, and 1840 miles of crude and gas gathering lines.

Gas Pipelines

Big news, of course, is that work will finally get underway on some segments of the long-planned Alaska Highway Gas Pipeline Project, principally in the pre-build sections of the western and eastern legs. Pacific Gas Transmission's plan is to install 160 miles of 36-in. in various loops on its system to increase gas flow capacity. Another 480 miles of 36-in. would remain to be installed later to provide a second 36-in. line from the Canadian border to the Oregon-California border. Pacific Gas & Electric's section of the western leg include 290 miles of 36-in. to be installed later.

1980 PIPELINE OUTLOOK

Type of Line	Miles Planned, Pipeline Projects	
	U.S.	Canada
Natural Gas	14,399	8,810
Crude Oil	5,075	1,434
Products	3,168	600
Slurry	7,965	—
TOTALS	29,607	10,844
GRAND TOTAL, U.S. and Canada	40,451	

Projected 1980 Completion, Miles		
Type of Line	U.S.	Canada
Natural Gas	3,760	4,000
Crude Oil	1,121	
Products	1,047	
Slurry	—	
Oil/Gas Gathering	1,840	4,000
	<u>7,268</u>	
GRAND TOTAL		<u>11,268</u>

Pacific Gas Transmission has another major gas supply project in the works — 695 miles of 20-, 30-, and 36-in. line from the Green River Basin of Wyoming to California, with the line route crossing Utah into Nevada and on into southeastern California.

Final arrangements on the \$500-million Trailblazer Pipeline System to move gas from the Rock Springs area of Wyoming and Utah to western, midwestern, and eastern markets have been made by the four interstate gas transmission firms who will participate in the system. Mountain Fuel Supply Co. will build and operate the 88-mile, 30-in. Overthrust Pipeline section in western Wyoming. Colorado Interstate will build and operate a 264-mile, 36-in. section from Rock Springs to south of Cheyenne. The eastern section, Trailblazer Pipeline Co. will be owned jointly by an affiliate of Natural Gas Pipeline Co. of America (Peoples Gas of Chicago) and Columbia Gulf Transmission Co. The 445-mile, 36-in. section will be built and operated by NGPLA.

United Gas Pipe Line Co. is extending its system to the Panhandle area of Texas and a connection with Colorado Interstate Gas Co.'s system in the Hugoton-Panhandle Field that could eventually lead to interconnections and transportation of Rocky Mountain natural gas to Louisiana. United's proposal is for a 635-mile, 30-in. line from Moore County, Tex. across Oklahoma and southwest Arkansas to near West Monroe, La. The \$386 million would initially have five compressor stations.

Northern Natural Gas is getting deeper into Texas with plans to build a 160-mile, 12-in. or larger gas pipeline in southwestern Texas at a cost of \$35 million.

In the northeastern U.S., Algonquin Gas Transmission Co. and Transcontinental Gas Pipe Line Corp. propose to take gas from Q&M Pipelines Ltd. at the New Brunswick-Maine border and transport it south to as far as Rhode Island, beginning in 1983. Plan is based on proposals by Q&M and Pan-Alberta Gas Ltd. to transport gas from eastern Quebec to the Maritime Provinces and to export up to 250 MMcf per day to U.S. markets.

Northern border Pipeline Co., the eastern leg of the Alaska Highway Gas Pipeline Project, is likely to get construction underway on some sections of its 809-mile, 42-in. line into Ventura, Iowa pending final FERC approvals, pipe deliveries, and closing out any possible ROW problems.

Hearings continued in December on the Ozark Gas Pipeline project to build 445 miles of 4 to 20-in. pipelines in Oklahoma and Arkansas and provide a new outlet for gas from the Anadarko Basin.

United Texas Gas Transmission Co., an affiliate of United Gas Pipeline, has under construction 284 miles of 30-in. in south Texas, between Katy and Laredo.

Mountain Fuel Supply Co., expanding its system to acquire new gas supplies, plans 300 miles of 1- thru 8-in. laterals in Utah and Wyoming.

With the American Natural Resources coal gasification plant in North Dakota, Great Lakes Gas Transmission Co.'s proposed 365-mile, 30-in. line from Mercer County, N. Dak. to Thief River Falls, Minn. gains new life. Line will not be required until plant is operational, but work on design and engineering is expected to be renewed.

Carbon Dioxide Pipelines

Four proposals involving the transportation of carbon dioxide from areas where it can be recovered to areas where it can be used in enhanced oil recovery projects are also in the news. One line, 72 miles of 6- and 8-in. by Transpetco., is currently before the FERC. Line would be built in the Texas Panhandle, originating near Borger.

Atlantic Richfield Co. still has under study a 375-mile, 20-in. line from the Raton Basin of Colorado to near Yoakum, Texas.

Shell Oil's Cortez Pipeline Co. also has plans for a major 16- or 20-in. CO₂ line from near Cortez, Colo. to West Texas. And in Mississippi, Shell Pipe Line Co. is working on plans for a 90-mile, 20-in. CO₂ line.

Other projects reportedly are in the mill as producers look for new ways to increase production from existing oil fields, especially those where surplus carbon dioxide from other areas can be put to good use stimulating oil recovery.

Crude Oil Pipelines

Northern Tier Pipeline Co. has passed all of the tests so far in its quest for authority to begin construction on its 1557 mile, 40- and 42-in. oil pipeline designed to transport Alaskan and other imported crude oil from the Pacific Coast to Midwestern refineries and markets. Fate of the line is now in the hands of President Carter, who is expected to give the project a green light.

The line did receive a mixed approval from former interior secretary Andrus, who suggested the pipeline company should arrange all of its financing within one year — but also suggested that the line make extensive changes in its westernmost route near Seattle and also find another terminal site.

Northern Pipeline Co. (of Delaware) has yet to get its project moving in efforts to build a 480-mile, 24-in. line to transport crude oil from Wood River, Ill. to St. Paul, Minn. Right-of-way acquisitions have been a large stumbling block for the line.

Other major crude oil projects on the books include a 204-mile, 16-in. line from Kingman to a proposed refinery at Mobil, Ariz. at a cost of \$38 million; Sioux Pipeline Co., which plans a 160-mile, 10-in. line linking St. Paul, Minn. and Superior, Wis., and Northville Industries, which plans 174 miles of 30-in. between Texas City, Tex. and Nederland, Tex.

Products Pipelines

Colonial Pipeline Co., whose 1979 program included 230 miles of 36- and 40-in. parallel line adjacent to its mainline and 100 miles of 16-in. lateral between Atlanta and Chattanooga, has another major segment in the works for 1980. New construction will involve 150 miles of 36-in. between Richmond, Va. and the Baltimore, Md. area.

Barbour Energy reportedly is studying plans for 390 miles of 20-in. to link Brownsville, Tex. to Houston.

Hydrocarbon Transportation Inc. is working on 240 miles of 10-in. line to move natural gas liquids from Buston, Kan. to Plattsburg, Mo.

Mapco, Tulsa-based pipeline transporter of NGL, is expected to expand westward with a 700-mile, 10-in. system from Kutz, N. Mex. to Wyoming and Utah producing areas and NGL extraction plants.

Biggest project lying in the wings is the 890-mile, 24-in. Transgulf Pipeline project involving conversion of an existing natural gas line to products transportation. The 24-in. line would be abandoned by Florida Gas Transmission Co. so conversion could be attained.

Slurry Pipelines

There are eight projects involving 7965 miles of pipeline in the slurry pipeline category — all designed to move coal in slurry form from mostly western mining areas to electric generating plant sites across the country stretching from the Pacific Northwest to Florida. Project closest to getting underway is Energy Transportation Systems, Inc., with rights to go ahead with R-O-W acquisition in most of its territory.

Even though the current Congress has not made a favorable move to provide right of *eminent domain* to the slurry pipelines, the companies involved are confident that it will be eventually granted, and continue to work on firming up their project designs.

P&GJ

Planned And Proposed Pipeline Projects

U.S.—Natural Gas Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Alabama-Tennessee Natural Gas Co.	17.7	8	Lamar Co. Miss		3.5	Approved	
	11	12	Colbert Co. Ala		1.7	Before FERC	
Ammonia Enterprises Pipe Line Inc.	52	10	Onshore-offshore La			Before FERC	
Arkansas-Louisiana Gas Co.	28.4	various	Arkoma Basin, Okla. gathering			Awaits start	
	17.5	18	Chiles Dome Field, Okla.			Bids out	
	16.7	30	Northwest Ark.			Planned	
Atlantic Richfield Co.	375	20	Raton Basin, Colo.	Yoakum, Tex. (CO ₂ line)		Under study	
Big Three Industries	190	12	Freeport, Tex.	Victoria, Tex.		Awaits start	
	10	12	Dickinson, Tex.			Underway	Goldrus Constr.
	6	12	Beaumont, Tex.			Underway	
	3.5	20	Bayport, Tex.			Underway	
Colorado Interstate Gas Co.	52	24	Green River/Rawlins, Colo. loop			Before FERC	Belmont Constr. Inc.
Columbia Gas Transmission Corp.	191	16-20	Va. & W.Va.		46	Awaits bidding	
	73.8	4-24	Crawford Storage Field, Ohio Phase II			Awaits bidding	
	41	1-24	W.Va. N.Y. & Pa. & Ohio compression		7.7	Before FERC	
	23.5	2-36	W.Va. Ohio Pa. & Ky.			Before FERC	
	19.6	6	Kanawha Co., W.Va.			Awaits bidding	
	14.5	10	Fairfield, Hocking & Athens Cos., Ohio			Underway	Carl E. Smith, Inc.
	4	30	Acahita Parish, La.		2.3	Before FERC	
Columbia Gulf Transmission Corp. & Natural Gas Pipeline Co. of America	127.7	10, 12, 20	Eugene Is. & W. Cameron Areas, offshore La.			Before FERC	
Columbia Gulf Transmission Co. & Northern Natural Gas Co.	25.5	16, 30	Offshore La.		24	Approved	
Consumers Power Co.	22	4, 6	Northern Mich.			Planned	
	8	4	Southern Mich.			Planned	
Cortez Pipeline Co. (Shell)	500	16 or 20	Cortez, Colo. CO ₂ line to West Tex.			Under study	
Dehti Gas Pipe Line Co.	433	4-8	East Tex. & Gulf Coast			Planned	
	65	4-12	Okla. & Tex.			Planned	
	59	4	Tex. Panhandle gathering			Planned	
Diamond Shamrock Corp.	463	30-36	Port O'Connor, Tex.	St. Stockton, Tex.		Before FERC	
El Paso Natural Gas Co.	120	24, 30, 32	San Juan, Eddy & McKinley Cos., N.M.		69	Before FERC	
	47.7	4-16	Permian, Tex. N.M. area			Before FERC	
	35.1	6-20	Hemphill, Tex. & Roger Mills Co., Okla.			Before FERC	
	33.9	24	Ignacio, Colo.	Toprock, Ariz.		Before FERC	
	30	4-20	San Juan Co., N.M.			Delayed	
	27.5	4-12	Webb & Zapata Cos., Tex.			Planned	
	18	6-10	Offshore Tex.		14.1	Approved	
Enterprise Pipeline Co. of Texas	52	6	Gonzville, La.	Grangeville, La.		Approved	
Enterprise Products Co.	25	16	Houston Ship Channel	Mont Belvieu, Tex.		Bids called	
Eugene Island Pipeline System	108	20	Block 128, S. Marsh Is., offshore Tex.	Carlou Is.		Planned	
Farmland Industries	100	12, 16	Pollock, La.	Humphreys, La.		Before USCE	
	50	16	Baldwin, La.	Scott, La.		Planned	
	20	12	Bay Marchand area, offshore La.			Before USCE	
Farmland Industries & Louisiana Intrastate Gas Corp.	51	24, 36	Humphreys, La.	Donaldsonville, La.		Planned	
Florida Gas Transmission Co.	51.2	26, 30	Zachry, La.	Fl. Lauderdale, Fla.		Approved	
	41.3	2, 20	Block 665, Matagorda Is. area	Refugio Co., Tex.	24.7	Before FERC	
	23	8, 10	Block 340, Brazos area, offshore Tex.	Matagorda Co., Tex.		Planned	
	17.2	4-20	Orlando, Fla. area			Approved	
	13	10	Block 721, Matagorda Is. area	San Patricio Co., Tex.		Planned	
	1.6	10	Block 830, Matagorda Is. area			Approved	
Great Lakes Transmission Co.	365	30	Mercer Co., N.D. SNG line	Thief River Falls, Minn.		Before FERC	
	125	30, 36	Minn., Wisc. & Mich.		70.6	Before FERC	
	50	10-14	South Tex.			Planned	
Gulf Energy & Development Co.	195	4-12	Bowdon area, Valley Co., Mont.		8.4	Awaits start	
Kansas-Nebraska Natural Gas Co.	24.3	20	Cameron Parish, La.			Bidding	
Louisiana Resources Co.	18.2	20	Cameron Parish, La.			Delayed	
Memphis Light, Gas & Water	26	6-22	Memphis area			Planned	
Mexoil Corp.	25	8	La.			Planned	
Michigan-Wisconsin Pipe Line Co.	93	36-42	La. Miss. Tenn. Ky. & Ind. loop, Ohio & Mich. Innn.		78.1	Before FERC	
	66.9	6-20	Woodward-Laverne area, Okla.			Approved	
	63	12-30	Offshore Louisiana			Planned	
	27.7	30	Mich. & Wisc.			Before FERC	
	12	42	Mich., Ind. & Ill. loop		15.9	Before FERC	
Montana Fuel Supply Co.	6.5	42	Joliet, Ill. area loop		6.1	Before FERC	
Montana Power Co.	35	10	Converse Co., Wyo.	Douglas, Wyo.		Before FERC	
Mountain Fuel Supply Co.	16	6	Leroy Field, Mont.			Planned	
National Fuel Gas Supply Corp.	300	1-8	Utah & Wyo.		23.7	Before FERC	
& Natural Gas Storage Corp.	22	4-12, 16-36	Ellisburg, Pa.			Planned	
Natural Gas Pipeline Co. of America	27.5	30	Ingleside, Tex.	Sinton, Tex.		Before FERC	
	27	8	Bryan-Marshall Cos.	Love Co., Okla.	2.7	Before FERC	
	8	16-20	High Is. area, offshore Tex.			Underway	
Natural Gas Pipeline Co. of America, Colorado Interstate Gas Co., Columbia Gulf Transmission Co., Mountain Fuel Supply Co. (Trailblazer System)	797	30, 36	Rock Springs, Wyo.	Beatrice, Neb.	400	Before FERC	
Northern Border Pipeline Co.	809	42	Near Monchy, Sask.	Ventura, Iowa		Before FERC	Williams Bros.
Northern Natural Gas Co.	180	12	Batesville, Tex.	Eldorado, Tex.	35	Before FERC	
	50	12	Eddy Co., N.M.	Hobbs, N.M.	13	Before FERC	
	42	24	Block 686, Matagorda Is. area	Refugio Co., Tex.	80	Before FERC	
Northwest Alaska Pipeline Corp.	739	48	Prudhoe Bay	Alaska-Yukon border	5000	Before FERC	
Northwest Pipeline Corp.	359	30	Wash. & Ore.			Before FERC	
	358	24, 30	Stanfield, Ore.	Twin Falls, Idaho		Before FERC	
	82	4-12	Moxa Arch area, Wyo.			Before FERC	
	49	10, 16, 20	Uinta Co., Wyo.			Before FERC	
	43	20	Ore. & Idaho loops			Before FERC	
Nueces Co.	29	4, 6	Kit Carson & Bent Cos., Colo. to Colorado Interstate System			Before FERC	
Oklahoma Natural Gas Co.	98	2-30	Okla. projects			Planned	
Ozark Gas Pipeline Corp.	445	20, 4-10	Pittsburg Co., Okla. mainline & gathering to White Co., Ark.		104	Before FERC	
Pacific Gas & Electric Co.	290	36	Main, Ore.	Brentwood, Calif.		Planned	
	40	30	Searchlight, Nev.	Southeast Calif.		Under study	
Pacific Gas Transmission Co.	685	20, 30, 36	Green River Basin, Wyo. to Southeastern Calif.		341	Before FERC	

U.S.—Natural Gas Pipelines

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COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Pacific Gas Transmission Co.	592	36	Kingsgate, B.C.	Main, Ore.		Partial approval	
Panhandle Eastern Pipeline Co.	32	8-10	Major Co., Okla.		4.9	Before FERC	
	23	16	Kingsfisher Co., Okla.; Sooner System		10.1	Underway	Cap-Con Internati.
	21	4-10	Woods & Woodward cos., Okla.		6.1	Before FERC	
Seagull Pipeline Corp.			Brazos area, offshore Tex. to Sargent, Tex.				
Shell Pipe Line Co.	14	8			4	Planned	
Southern California	90	20	Rankin Co., Miss.	Lincoln Co., Miss.		Planned—CO ₂ line	
LNG Terminal Co.	63	32	Ventura Co., Calif.			Before FERC	
Southern Natural Gas Co.	48	12	Heflin, Ala.	Chattanooga, Tenn.		Before FERC	
	31	20	Thomaston, Ga.	Griffin, Ga.		Before FERC	
	24	6-20	Bienville Parish, La.			Underway	
	20.7	18	South Atlanta, Ga.	Thomaston, Ga.		Before FERC	
	13	12	Lake St. Catherine	Lake Ponchartraine, La.	5.2	Before FERC	
Southern Natural Gas Co. & Tennessee Gas Pipeline Co.	8.4	24	Bear Creek & Ysclosky areas, La.			Awaits start	
Southern Union Co.	11	16	Albuquerque	Sandoval & Bernalillo cos., N.M.		Planned	
	2	6	Amoco Nellis line, N.M. to Lea Co., N.M.			Planned	
	2	4	Lea Co., N.M.			Planned	
Southwest Gas Storage Co. & Panhandle Eastern Pipeline Co.	30	various	Borchers North Field, Meade Co., Kans.		72.9	Before FERC	
Sterling Pipeline Co.	60	12-16	Okla. transmission & gathering			Awaits start	
	100	N/A	Lee & Fayette cos., Tex.			Underway	H&K Constr.
Sun Pipeline Co.	6	6	Vetma, Okla.	Duncan, Okla.		Planned	
Texas Gas Corp.	32	8	West Texas			Planned	
Texas Gas Corp. & Coronado Transmission Corp.	22	8	Zapata Co., Tex.			Planned	
Tenneco Inc.	450	26	St. Johns, N.B.	Nassau, N.Y.		Planned	
	82	14, 18, 24	Baton Rouge, La.	Ft. Lauderdale, Fla.		Before FERC	
Tennessee Gas Pipeline Co.			Block 493, W. Cameron area, offshore La.	Block 227, E. Cameron area	40.5	Before FERC	
	30	30	Ruston, La.			Underway	Gregory & Cook
	22	36	Block 116A, S. Marsh Is. area	Block 108, S. Marsh Is. area	3.6	Before FERC	
	6	8					
Tennessee Gas Pipeline Co. & Columbia Gulf Transmission Co.	26	26, 36	South Pass area, offshore La.		98.8	Before FERC	
Texas Eastern Gas Pipeline Co.	12	12	Block 384, Eugene Is. area			Planned	
	10	12	Block A568, High Is. area, offshore Tex.	Block A540		Planned	
Texas Gas Transmission Co.	7	4	Terrebonne Parish, La.			Before USCE	
	15	12	Jefferson Davis Parish, La.			Planned	
Texas Sea Rim Pipeline Inc.	14	14	Sabine Pass Area, offshore Tex.			Before FERC	
Transcontinental Gas Pipeline Corp.	33.7	4-12	Onshore La. & Tex.		7.4	Before FERC	
			Block A7, Matagorda Is. Area, offshore Tex.	Block A620			
	27	12	Block 131, Galveston Area, offshore Tex.	Block A531, High Is. Area	13.2	Before FERC	
	19	16	W. Cameron Area, South Addition			Before FERC	
	18.5	4-12	Block 498, W. Cameron	Block A264, HIOS	4.1	Before FERC	
	17	20	Sabine River, La., loop			Before FERC	
	14	24	Calcasieu Parish, La., lateral			Before FERC	
	13	36	Block A85, Mustang Is. Area, offshore Tex.	Block A133, Brazos Area	10.4	Before FERC	Ford, Bacon & Davis
	13	20	High Is. Area, East Addition			Planned	
	7.5	8-12	Block 120K, Ship Shoal Area, offshore La.	Block 137	2.4	Before FERC	
	5.4	16	Block 34, West Delta Area, offshore La.	Blocks 31 & 32	3.3	Before FERC	
	4.8	6.8	Block A548, High Is. Area	Block A546, HIOS	3	Before FERC	
	3	16	Block 185A-B, S. Timbalier Area, offshore La.			Planned	
	2.8	8	Block A467, High Is. Area		2.3	Before FERC	
	2	12	Block 310B, Vermilion Area to Block 313			Planned	
	2	12	Block 494, W. Cameron Area	Block 498	2.6	Before FERC	
	1	16	Block A492, High Is. Area			Planned	
	1	12				Planned	
Transcontinental Gas Pipeline Corp. & Algonquin Gas Transmission Corp.	350	N/A	Near Calais, Me.	Burrillville, R.I.	420	Planned	
Transco, Columbia Gulf, Northern Natural & Texas Gas Transmission Co.	31	12, 16, 20	High Is. & Galveston areas, offshore Tex.		32	Approved by FERC	
Transok Pipeline Co.	63	24	Dustin, Okla.	Tulsa (CO ₂ line)		Underway	Great Plains Constr.
Transpetco	72	6.8	Borger, Tex. area			Before FERC	Eagleton Engineering
Transwestern Pipeline Co.	60	6-10	Tex. & N.M.			Planned	McVean & Barlow, Flint
Trunkline Gas Co.	22	24	La.			Before USCE	
	30	30	Lake Charles, La.				Banister Pipelines America
TXO Gathering Co.	16	N/A	Colo., Okla. & Tex.			Underway	
United Gas Pipeline Co.	21.5	30	Erath, La.	Weeks Is. Junc., La.	12.7	Planned	
	13	20	Livingston, Tex.			Await start	
	2	10	Terrebonne Parish, La.			Underway	Gregory & Cook
			West Monroe Junc., La. to Texas			Before USCE	
United Texas Gas Transmission Co.	635	30	Panhandle		386	Before FERC	
Western LNG Terminal	284	30	Katy, Tex.	Laredo, Tex.	110	Underway	Curran Houston Inc.
Western Slope Gas Co.	286	42, 48	Point Conception, Calif.			Before FERC	
	200	6, 10, 12	Colo.			Planned	
	20	12	Colo.			Await start	

U.S.—Crude Oil Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
ARCO Pipeline Co.	32	36	Texas City, Tex.	Houston		Bids out	
Ashland Pipeline Co.	14	20	Cattlettsburg, Ky.	Irondon, Ill.		Planned	
Chevron	5	18	San Pueblo, Calif.	Richmond, Calif.		Designing	
Continental Oil Co.	20	10	Cameron Area, offshore La.			Before FERC	
DEEPORT	31	36	Harbor Is. Bay, Tex.	Corpus Christi	500	Proposed	
Department of Energy							Parsons-Gilbane
	57	36	Weeks Is., La.	St. James, La.	27.8	Underway	Banister
	49	36	Bayou Chocklaw salt dome	St. James, La.		Underway	Houston
	42	24	Kleer Mine Storage	Texoma, Tex.		Approved	

U.S.—Crude Oil Pipelines

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COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Exxon U.S.A.	25	36	W Hackberry, La. storage dome	Block 42, W. Cameron area, offshore La.		Awaits bidding	
	14	16	Eastern Ky. strategic storage			Proposed	
	13	20	Southern Ohio strategic storage			Proposed	
	8	6, 10, 16	Corpus Christi area			Planned	
Gulf Oil Corp.	4.8	6, 8, 12	Hondo (Platform, Santa Barbara Channel)	SALM area		Awaits start	Alaska Constructors
	61	8, 16	Iberia, Vermilion & Cameron areas, offshore La.			Before USCE	
	37	6, 12, 16	Grand Is. & S. Timberline areas, offshore La.			Planned	
	32	12	Cameron Area, offshore La.			Approved	
	27	12, 20	Terrebonne & Lafourche parishes, offshore La.			Before USCE	
	24	14, 16	Block 33, Cameron Area to Block 235			Approved	
Koch Exploration Co.	18	6	St. Bernard & Orleans parishes, La.	St. James, La.		Before USCE	
	55	48	Phase I — Clovelly Storage Terminal, La.			Approved	
Loop Inc.	44	24	Phase I — Clovelly Storage Terminal, La.	Norco, La.	100	Planned	
	1.5	56	Phase II — SPM's			Proposed	
	21	48	Phase II — Pump platform			Proposed	
	29	48	Phase II — Beach			Proposed	
	3.4	56	Phase III — SPM's			Proposed	
	21	48	Phase III — Pump platform			Proposed	
Marathon Pipe Line Co.	29	48	Phase III — Beach	Clovelly storage area		Proposed	
	20.7	24, 30	St. James & St. John the Baptist parishes, La.			Proposed	
New England Energy Co.	35	24	Portland, Me.	Sanford, Me.		Underway	H. C. Price Co.
Northern Pipe Line Co. of Delaware	490	24	Wood River, Ill.	Pine Bend, Minn.		Planned	
Northern Tier Pipeline Co.	1557	40, 42	Port Angeles, Wash.	Clearbrook, Minn.	1400	Engineering	Butler, Williams Bros.
Northville Industries Inc.	174	30	Texas City, Tex.	Houston-Freepoint-Nederland		Before USCE	
Phillips Pipeline Co.	18 (dual)	N/A	Pelican Is., offshore Tex.	Texas City, Tex.		Before USCE	
	20	10	San Bernard, Tex.			Planned	
Provident Energy Co.	204	16	Kingman, Ariz.	Mobil, Ariz., refinery (proposed)	38	Planned	
Santa Fe Energy Co.	24	24	Trinity Co., Tex.			Engineering	
Shell Oil Co.	41	6, 8	Vermilion & S. Marsh Is. areas			Before USCE	
	28	12	Block 128, Mississippi Canyon, offshore La.			Planned	
	20	12	W. Delta & Grand Is. areas			Before USCE	
	16	16	Long Beach Harbor	Platform Ellen, San Pedro, Calif.		Underway	Alaska Constructors
	9	8	Block 311, Mississippi Canyon, offshore La.			Planned	
	5	42	Long Beach, Calif.	Wilmington, Calif.		Underway	Hood Corp.
	2	16	Long Beach	San Pedro Bay		Planned	
Sioux Pipeline Co.	160	10	Superior, Wisc.	St. Paul, Minn.		Planned	
Southern Union Refining Co.	47	8	Midland, Tex.	Lovington, N.M.		Engineering	International Pipeline Engrs.
Southwestern Gas Pipeline Co.	27	12	Midlap, Tex.	Morgan Mill, Tex.		Planned	Morgan Constr. Co.
Texaco Inc.	21	6, 8	Port Arthur, Tex.			Planned	
Texas Deepwater Port Authority	26 (dual)	52	Offshore Freepoint, Tex.	to shore		Approved	
U.S. Navy	135	30	Naval Petroleum Reserve	Redland, Calif.		Approved	Pipe Line Tech.
Wallace & Wallace Chemical & Oil Co.	47	4-24	San Joaquin Valley, Calif.			Underway	Granite Constr. Co.
	214	22-30	Mobile, Ala.	Tuskegee, Ala.		Planned	Ford, Bacon & Davis
Williams Pipe Line Co.	112	18	Des Moines, Iowa	Clear Lake, Minn.	25	Planned	
Williams Pipe Line Co.	163	12	Minneapolis/St. Paul	Lake Superior Refineries		Under study	
	691	24	Cushing, Okla.	Mason City, Iowa		Under study	

U.S.—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Barbour Energy Co., Inc.	390	20	Brownsville, Tex.	Houston		Under study	Ford, Bacon & Davis
Cainev Pipeline Co.	54	6	George AFB, Calif.	Edwards AFB, Calif.		Planned	
Chase Pipeline Co.	190	12	Scott City, Kans.	Wichita		Underway	Great Plains Constr.
Colonial Pipeline Co.	150	36	Richmond, Va.	Baltimore, MD.		Planned	
Enterprise Products Co.	55	6	Jay, Fla.	Ala.-Miss. border		Planned	
Exxon Pipeline Co.	15	6	Baton Rouge area			Planned	
	11	8	Baton Rouge area			Planned	
Getty Pipeline Inc.	25	16	Delaware City, Del.	Marcus Hook, Pa.	10	Delayed for EIS	Worthy Bros.
Hydrocarbon Transportation Inc.	240	10	Bushton, Kans.	Plattsburg, Mo.	30	Approved	
Loop Inc.	21	4	Onshore Lafourche Parish, La.	Pump platform		Approved	
Mapco Inc.	700	10	Kutz, N.M.	Wyo.-Utah	80	Planned	
Shell Oil Co.	254	12	Napoleonville, La.	Mt. Belvieu, Tex.	50	Underway	
	32	4	Payner, Tex.	Eustace, Tex.		Planned	
	19	4-8	Norco, La.	Avondale, La.		Planned	
	3	6	Geismar, La.			Planned	
Shell Pipe Line Corp.	28	10	Norco, La.	Sorrento, La.		Planned	
Transgulf Pipeline Co.	800	24	Baton Rouge, La.	Ft. Lauderdale, Fla.	125	Planned — conversion from gas to products	
Southern Pacific Pipeline, Inc.	36	24	Norwalk, Calif.	Colton, Calif.		Planned	
Union Carbide Corp.	13	6	Napoleonville, La. area			Planned	
U.S. Navy	8	10	Point Loma, San Diego Bay	North Is. Nav. Air Sta.		Underway	Hood Corp.
Williams Pipe Line Co.	691	24	Cushing, Okla.	Mason City, Iowa		Under study	

U.S.—Slurry Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Boeing Engineering & Construction Co.	645	N/A	Utah	Calif.		Planned	
ETSI	1380	38	Northeastern Wyo.	Baton Rouge		Planned	
Florida Gas Co.	1500	28-48	Eastern Ky./W. Va.	Ga. & Fla.		Planned	
Houston Natural Gas Co.	900	18	Colo.-N.M. border	Texas Gulf		Planned	
Nevada Power Co.	180	22	Las Vegas	Altam, Utah		Planned	
Northwest Pipeline Corp. & Gulf Interstate Engineering	1100	N/A	Northeastern Wyo.	Ore.-Wash. border		Proposed	
Tesoro Petroleum Corp.	1000	N/A	Ky.	Southeastern States		Under study	Fluor Corp., Dames & Moore
Texas Eastern Transmission Corp. & Brown & Root Inc.	1260	36-40	Mont.	Texas Gulf		Under study	

Construction Forecast

Canada Expects 4000-Mile Year in 1980

by L. O. Rowland, Canadian Editor

Big-inch pipeline construction in Canada will begin to pull out of its multi-year slump in 1980 if the Federal Government moves quickly to implement whatever recommendation for additional gas export was expected to be contained in the National Energy Board report on a group of applications for a total of more than 1 billion cu ft per day for a short term.

Favorable, early treatment of the Pan-Alberta Gas Group and Progas applications can result in the start of prebuilding of gas transmission line facilities which will ultimately be shared with Alaska gas as integral parts of the Northwest-Foothills project. Although the 1980 program, as drafted tentatively pending the NEB decision (which was expected late in November), amounts to only

about 135 miles of 36-inch pipe, it will be followed up in 1981 by more than 400 miles of 36-, 42- and possibly some of the 56-in. pipe.

The 1980 plans involve what will, in effect, be loops of part of the existing Alberta Gas Trunk Line and Alberta Natural Gas systems to carry gas for California through what will eventually become the western leg of the Northwest-Foothills line. The 1981 construction will be lines required to carry Canadian gas into the Northern Border system for delivery east, and will include an across-Alberta line and a connecting transverse line through southwestern Saskatchewan. This ultimately will become part of the eastern leg of Northwest-Foothills.

Apart from these prospects, the immediate outlook for

CANADA—Natural Gas Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST (\$MILLION)	STATUS	CONTRACTOR OR ENGINEERING CO.
Alberta Natural Gas Ltd.	300	Var	Gas gathering laterals in Alberta			Planned	
Esso Resources Canada Ltd.	290	10	Fort MacMurray, Alta.	Judy Creek, Alta.		Planned	(CD) line
	60	6					
Foothills Pipeline Ltd.	2032	42-48/56	Alaska-Yukon border	Alberta-U.S. border	4300	Awaiting NEB Approval	
Foothills Pipeline Ltd.	740	34	Near Whitehorse	Blackenzie Delta area	2500	Planned	(Demopster lateral)
Polar Gas Project	2338	36/42	Malville Island	Longlac, Ontario		Planned	
Q&M Pipelines Ltd.	1140	4 to 30	Quebec	Newa Scotia		Planned	
Shell Canada Resources Ltd.	32	14	Ram River	Limestone Field		Planned	
Shell Canada Resources Ltd.	80	12-24	Northeast British Columbia laterals			Planned	
TransCanada Pipelines Ltd.	30	36	Maple, Ontario	Lugar, Ontario		Planned	
TransCanada Pipelines Ltd.			Quebec and Maritime Provinces (GAS EAST project)			Planned	
TransCanada Pipelines Ltd.	1012	12 to 30				Planned	
TransCanada Pipelines Ltd.	25	6	Thorn, Ontario	Meniscanning, Quebec		Planned	
TransCanada Pipelines Ltd.	125	24	Sable Island	Canso, Nova Scotia		Planned	
Westcoast Transmission Co. Ltd.			British Columbia mainland to Vancouver Island			Planned	
Westcoast Transmission Co. Ltd.	506	2-4/8-16			280	Planned	
Westcoast Transmission Co. Ltd.	100	36	Loops on main line in British Columbia			Planned	

CANADA—Products Pipelines

Amoco Canada Petroleum Co. Ltd.	500	12	Sarnia, Ontario	Quebec City, Quebec	Planned
Pan Canadian Petroleum Co. Ltd.	100	10	LPG Line		Planned

CANADA—Crude Oil Pipelines

Esso Resources Canada Ltd. (Interprovincial Pipeline Ltd.)	560	12	Norman Wells, Northwest Territories to Zama, Alberta		Planned
Husky Oil Co.	600	2 to 12	Oil gathering system in Alberta and Saskatchewan		Planned
Murphy Oil Co. Ltd.	38	10	Unity, Saskatchewan area		Planned
Peace Pipe Line Ltd.	146	12	Fox Creek, Alta.	Grande Prairie, Alta.	Planned
Peace Pipe Line Ltd.	100	10	Oil Line		Planned



— Jerry Lozynsky, Marine Pipeline

Westcoast Transmission Co., Ltd.'s 36-in. crossed rugged terrain.

1980 will be enhanced by the catalytic effect on related lines that will have to be built to connect new gas reserves tied into the export approvals. There is no reliable figure for total volume, but a reasonable assumption is that up to 300 miles of laterals will be built by Alberta Gas Trunk Line and others in relation to the western leg.

Westcoast Transmission Co., Ltd. has tentative plans to go ahead with its deferred program of looping out all the remaining gaps in its main line loop, of which only about 100 miles remain to be filled-in to provide two complete lines from the Taylor gas plant to Huntingdon, B.C. The loop will be done with 36-in. pipe, but the extent to which this can be done in 1980 depends on somewhat unpredictable reaction of the National Energy Board as to the imminence of this requirement. It will be needed in any case by 1981 because of indicated growth of the American market, now being served, but which has been subject to cutbacks in the past three winters when gas was in short supply.

Westcoast has a firm program of winter construction of about 80 miles of lateral gas gathering main lines in north-eastern British Columbia for completion in the spring. These are large diameters for gathering lines from 12- to 24-in. Shell Canada has awarded the contract for its main insulated sour gas line from Limestone Field to the Aquitaine Ram River gas processing plant, in the southern Alberta foothills; project consists of 32 miles of 14-in. with unusual specifications of 0.514-in. wall thickness and 2600 psig operating pressure — making an interesting technical construction job. Completion is set for early summer.

Because of the extreme concern over possible interruption to crude oil imports in the eastern provinces, there is increasing possibility of a start on the Q&M/Gas East project to move gas east of Montreal. The merger of the com-

peting plans of Q&M Pipelines, a subsidiary of Alberta Gas Trunk Line, and TransCanada PipeLines during the National Energy Board hearing has cleared the way for an early decision if the NEB shares the feeling of urgency expressed by the Quebec and Maritime Provinces premiers. Construction at least as far as Quebec City is possible, involving as much as 200 miles of 30- or 24-in. pipe. TCPL also has a proposal before the NEB to loop about 31 miles of its main line north of Toronto with 36-inch pipe next summer.

Among possible small-inch projects for 1980 are two proposals to move crude oil and LPG from the Deep

Basin west and north of Grande Prairie in northwestern Alberta to the Peace Pipe Line terminal at Valleyview and the Peace terminal at Simonette respectively. One is by Pan-Canadian Petroleum, the other by Peace Pipe Line, and each would involve about 100 miles of 10-in. pipe.

A number of other LPG and gas laterals in the planning stage, and those that should be required to bring on new fields to replace declining productivity in others could bring the total of small-inch mainline construction to about 1200 miles.

Field gathering systems offer a sustained volume of activity. There are more than 10,000 shut-in gas wells in

Alberta and 1000 or more could be required for the new export market if the full volume in the application is granted. This would provide a basic requirement for 1000 miles of gathering lines, in addition to the normal minimum of about 1000 miles that has been the standard for the past several years to maintain producibility in older fields and attach new fields being placed under sales contracts.

The internal buoyancy in Alberta from industrial development and population growth has kept up a rate of increase in gas demand not shared by the rest of Canada. In addition the substantial rise in oil well completions in both Alberta and Saskatchewan, with instant sales available, will provide a significant volume of perhaps 500 miles of oil gathering lines in 1980.

Water injection schemes and a moderate amount of gas utility distribution mains will probably add some 300 miles. Altogether, the categories of gathering, injection, and distribution lines for the year should provide upwards of 2800 miles. Taking the whole range, construction volume could reach 4300 miles or better, for an increase of about 50% over the low cyclical year 1978.

Two substantial small-inch projects not likely to be approved in time for 1980 completion, but possibly could be at least past the application stage before year's end, are the Esso Resources' Norman Wells oil pipeline and the Esso Resources carbon dioxide pipeline.

The Norman Wells proposal involves 560 miles of 12-in. pipe from Norman Wells Field in the Northwest Territories, up the Mackenzie Valley, and terminating at Zama in northern Alberta where it would connect with existing Alberta systems. It is designed to handle 25,000 bbl per day from this 58-year-old field, which has become economic for sale outside its locality only because of the high oil price. In case of a real squeeze on international supply, it is possible it might be expedited through the hearing process but unlikely to be completed before the summer of 1981 because it involves a great deal of winter muskeg terrain that is not economically accessible in summer.

The CO₂ project is a 350-mile line, including 290 miles of 10-in. and 60 miles of 6-in. pipe, which would carry CO₂ from the two Fort McMurray oil sands plants and the Esso fertilizer plant at Redwater to Esso's Judy Creek oil field for a miscible enhanced recovery scheme. The complexity of CO₂ recovery facilities and the groundwork for the miscible flood are such that completion before 1981 is very unlikely — but it could easily reach the tender call stage late in 1980.

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THE COVER

A maze of piping, exhaust stacks and mufflers, valves, and other essential equipment typifies a modern compressor station operated by a leading gas transmission company.

— Courtesy Panhandle Eastern Pipe Line Co.

Giant Oil/Gas Fields: Tomorrow's Hope . . . 21

During 1968-1978, 290 giant oil and gas fields were discovered around the world; they supply much of the petroleum energy now used internationally. For the future, says renowned geologist and independent producer Mike Halbouty, it is logical to assume that there are many other undiscovered giants waiting to be found, many of them offshore — and they will all need pipelines to move that energy to market.

How To Make Over-The-Line Surveys 26

Pros and cons of over-the-line surveys have been discussed and argued for many years — author does not debate the issue, but instead gives inside information on how to make such surveys, what equipment to use, methodology that can help, and some caveats of interest.

Abandoned, Corroded Line Rehabilitated . . 34

When Wheeling Pittsburgh Steel found it needed nitrogen at one plant, and had surplus nitrogen at another plant 15 miles away, a pipeline seemed the logical answer. Even better than having to install a new line, the firm found it had available an abandoned 15-mile, 10-in. coke oven gas line. The corroded line was cleaned and rehabilitated by a Pittsburgh firm specializing in such projects.

How Paving Affects Pipe-To-Soil Potentials 42

Effectiveness of cathodic protection of buried pipelines is monitored by accurate pipe-to-soil measurements — but such measurements of lines under paving aren't always accurate. Recent study reveals how various instruments perform, suggests ways to get better results.

5000 Miles of ROW For Sale 58

Important rights-of-way in the Northeast and Midwest, suitable and desirable for pipeline use, are now available for sale from the Penn Central Corp. — ROW acquired from predecessor companies of the Penn Central Transportation Co., once the nation's largest railroad.

How Archeology Affects Pipeline Route Selection 60

State, local, and federal regulations frequently require pipeline operators and builders to make an archaeological survey along the pipeline route before the digging begins; it's all an effort to preserve the valuable, buried origins of man's society. Here are details on why it is important. It is also the law.

First Base For Exploration —

Because oil companies have the heavy responsibility of seeking oil supplies, their first job is acquiring leases or concessions on land or offshore that have oil and natural gas potential.

Our table gives developed and undeveloped leases for 146 U.S. investor-owned oil/gas companies. Acreage is for 1978 as shown in most annual reports or provided by the companies.

U.S. acreage under lease is approximately 240 million acres for the 146 companies shown. This is only about 10% of the total 2.3 billion acres of the United States, including Alaska (375 million acres) as well as the other 49 states.

Independent Petroleum Association of America estimates all domestic acreage under lease for oil/gas exploration is 432 million acres — 19% of U.S. land available for lease. (Federal government owns 760.4 million acres — 33% of all U.S. lands.)

This is the most acreage under lease since 1959 when leaseholdings were about 424 million acres.

Decline in leaseholdings in the years since 1959 parallels decline in drilling brought on by wellhead price controls and increasing federal intervention in the energy business.

Now that price controls are being relaxed — if not dropped — the U.S. active rig count (2577 active rigs in December 1979) is higher than it's been in 20 years. And oil firms are leasing more acreage for prospecting.

It's getting harder to get leases on U.S. lands. There are many bills introduced to Congress each year to set aside more areas to be restricted "wilderness" — especially in Alaska. Already more than 19 million acres are part of the National Wilderness System — and are not available for any development.

Leaseholdings are getting more expensive, too. According to *Forbes*, lease prices/acre in Oklahoma have gone to \$275/acre from \$65/acre in 1976. Louisiana Gulf Coast acreages cost \$100/acre, up from \$25/acre in 1976.

ACREAGE LEASED FOR

Company	Developed Net Acreage		Undeveloped Net Acreage		*Reserves in million bbl net oil equivalent 12/31/78
	Year ended 12/31/78	U.S. Total	Year ended 12/31/78	U.S. Total	
1. Adams Resources & Energy	8,480	8,480	43,219	43,219	2
2. Adobe Oil	57,531	58,135	1,079,367	1,198,928	37
3. Altex Oil	38,935	38,935	210,033	210,033	1*
4. Amarex Inc.	48,627	48,627	95,686	95,686	15
5. Amco Energy	6,490	6,490	7,393	7,393	6
6. Amerada Hess	320,000	1,287,000	2,323,000	29,348,000	929
7. American Natural Resources	55,735	77,715	1,493,468	1,645,215	53
8. American Petrofina	210,276	210,276	568,028	568,028	69
9. American Quasar Petroleum	15,118	34,154	1,393,005	1,730,260	35
10. Aminoil (RJ Reynolds)	98,867	143,773	705,282	1,220,445	300
11. Apache Corp.	15,608	15,608	196,700	196,700	17
12. Arapaho Petroleum	11,027	11,084	91,743	101,973	11
13. Argonaut Energy	35,604	35,604	45,784	45,784	3
14. Argo Petroleum	9,765	11,571	58,701	87,160	16
15. Ashland Oil	820,000	969,000	1,736,000	5,820,000	266
16. Asamera	18,996	28,359	286,728	4,164,102	34
17. Atlantic Richfield	1,252,000	1,896,000	5,267,000	32,736,000	5,405
18. Basic Resources Corp.	0	23,157	0	1,546	
19. Beard Oil	18,715	18,715	2,103,135	2,103,135	4
20. Belco Petroleum	214,000	257,000	186,000	1,167,000	249
21. Brock Exploration	4,629	6,452	10,815	10,815	2
22. R.L. Burns Corp.	36,903	36,903			7
23. Buttes Gas & Oil	37,157	121,338	262,144	9,434,810	34
24. C&K Petroleum	30,579	30,579	233,000	459,824	14
25. Centura Petroleum	6,491	6,491	11,908	11,908	1
26. Champlin (Union Pacific)	314,500	347,000	1,133,678	1,246,921	323
27. Cities Service	1,700,000	1,900,000	10,100,000	24,600,000	975
28. Clark O&G	16,304	16,304	17,602	75,673	
29. Coastal States	756,947	765,947	3,436,948	3,436,948	254
30. Columbia Gas	1,380,965	1,388,389	4,021,956	8,163,864	2
31. Consolidated Natural Gas	886,544	886,544	4,325,743	4,325,743	203
32. Consolidated Oil & Gas	73,004	73,004	98,646	321,307	33
33. Conoco Inc.	1,252,912	2,230,310	3,389,000	69,743,000	3,239
34. Crown Central Petr.	71,772	71,772	137,562	142,356	9
35. Crystal Oil	60,613	60,613	208,961	208,961	17
36. Delhi International	663	39,237	13,190	25,638,223	136
37. Diamond Shamrock	521,029	521,029	2,502,190	2,502,190	192
38. Dorchester Gas	291,645	302,207	137,563	921,715	72
39. Dyco Petroleum	24,600	29,600	146,200	146,840	6
40. Echo Oil	5,096	5,096	61,479	61,479	1
41. El Paso Co.	953,298	953,298	1,326,067	1,500,702	1,059
42. Energy Minerals Corp.	20,707	20,707	128,155	128,155	4
43. Energy Reserves Group	321,307	321,307	1,339,145	4,874,726	69
44. Energy Sources	2,087	4,122	5,555	25,355	1
45. Enserch Corp.	387,497	389,293	1,153,344	1,718,270	56
46. Equity Oil	10,155	14,004	415,930	439,204	12
47. Exeter Oil	1,064	1,064	0	0	21
48. Exxon	4,332,000	19,850,000	11,306,000	203,394,000	28,212
49. Felmont Oil	64,921	65,898	159,063	208,937	14
50. Florida Exploration	10,653	10,653	94,553	94,553	13
51. Foerst Oil	104,290	110,307	346,365	752,564	73
52. Galaxy Oil	20,515	20,515	74,765	74,765	6
53. General American Oil	225,000	277,000	821,000	1,384,000	168
54. Getty Oil	929,000	1,010,000	4,749,000	21,784,000	2,714
55. W.P. Grace	185,930	197,787	652,802	1,012,562	137
56. Great Basins	12,094	90,919	478,949	897,225	46
57. Gulf Energy & Development	9,006	9,006	25,099	25,099	2
58. Gulf Oil Co.	1,876,000	4,220,000	12,785,000	43,240,000	3,323
59. Hadson Ohio	10,919	10,919	70,215	70,215	3
60. Hamilton Brothers Petr.	32,763	78,516	92,017	1,522,970	49
61. Helmerich & Payne	99,056	99,056	144,339	144,339	53
62. Helmet Petroleum	3,397	3,456	28,312	38,542	1
63. Holly Corp.	23,771	23,771	234,619	234,619	4
64. Houston Natural Gas	328,654	328,654	948,104	948,104	75
65. Houston Oil & Minerals	74,752	74,752	777,241	777,241	131
66. Husky Oil Ltd.	68,000	298,000	973,000	3,362,000	184
67. Inexco Oil	142,551	142,551	950,716	964,716	42
68. Juniper Petroleum	31,288	36,015	640,965	926,933	7
69. Kansas Nebraska Nat. Gas	337,402	337,402	3,296,074	3,296,074	152
70. Kerr-McGee Corp.	293,726	488,196	755,360	1,665,892	288
71. Kirby Exploration	5,245	5,317	238,134	238,134	4
72. Louisiana Land & Explora.	125,000	162,000	1,745,000	4,876,000	274
73. MGF Oil	9,800	9,800	275,000	275,000	4
74. Mapco	142,298	142,816	501,154	2,703,260	82
75. Marathon Oil	383,661	2,912,532	1,600,130	35,365,199	1,797

Acreage Under Lease

EXPLORATION/ PRODUCTION

Company	Developed Net Acreage		Undeveloped Net Acreage		*Reserves in million bbl net oil equivalent 12/31/78
	Year ended 12/31/78	U.S. Total	Year ended 12/31/78	U.S. Total	
76. Marion Corp	6,059	6,059	66,102	66,102	13
77. May Petroleum	39,406	39,406	230,832	230,832	408
78. Maynard Oil	55,139	55,139	123,628	123,628	28
79. McCulloch Oil	49,230 ¹	49,230	106,742 ¹	110,143	37
80. McFarland Energy	9,525	9,525	33,872	33,872	8
81. McMoran Oil & Gas	29,572	40,931	34,360	181,399	24
82. Mesa Petroleum	276,977	490,637	992,833	2,409,761	348
83. Mitchell Energy	443,600	443,600	1,000,100	1,000,100	145
84. Mobil Corp.	1,965,000	3,010,000	4,980,000	55,364,000	10,225
85. Mountain Fuel Supply	174,326	174,326	2,112,927	2,112,927	343
86. Murphy Oil	84,000	198,000	435,000	13,267,000	392
87. Natomas Co.	55,700	85,700 ^e	387,800	15,387,000 ^e	78
88. Noble Affiliates	80,490	184,330	393,891	493,551	53
89. North American Royalties	32,000	32,000	162,000	162,000	10
90. Northern Natural Gas	60,000	60,000	1,715,000	1,715,000	30
91. Northwest Energy			551,770	551,770	
92. Occidental Petroleum	38,420	1,927,980	156,067	6,754,272	1,174
93. Oklahoma Natural Gas	80,536	80,536	126,763	126,763	18
94. Oxoco	8,345	8,345	20,791	9,038,812	3
95. Panhandle Eastern	974,546	1,018,546	1,139,635	1,343,635	287
96. Patrick Petroleum	20,940	23,196	716,974	2,942,771	14
97. Patton Oil	4,584	4,584	53,937	53,937	
98. Peninsula Resources	4,336	4,336	28,334	28,334	2
99. Pennzoil Co.	828,961	883,779	2,554,475	6,158,071	322
100. Petroleum Development	5,297	5,297	176,969	176,969	2
101. Petro-Lewis	300,606	300,606	355,597	355,597	30
102. Phillips Petroleum	1,250,000	1,386,000	4,563,000	71,790,000	3,140
103. Pioneer Corp.	86,217	86,217	187,373	187,373	35
104. Premier Resources	12,879	31,849	11,496	36,463	3
105. Quaker State	66,413	66,413	287,343	287,343	33
106. Reading & Bates	32,599	1,341,058	567,384	2,127,384	17 ^e
107. Reserve Oil & Gas	76,023	140,257	557,336	2,169,952	79
108. Sabine Corp.	273,221	489,472	802,058	1,114,335	55
109. Santa Fe International	22,409	27,675	162,216	162,216	83
110. Seneca Oil	7,455	7,455	52,180	52,180	1 ^e
111. Shell Oil	976,000	1,028,000	12,960,000	56,019,000	2,931
112. Southern Natural Res.	46,718	46,718	153,017	153,017	43
113. Southern Union Co.	4,800	4,800	90,700	90,700	4
114. Southland Royalty	656,000	656,000	2,057,000	2,057,000	299
115. Standard California	1,461,000	2,951,000	6,401,000	137,934,000	17,163
116. Standard Indiana	2,785,000	3,752,000	23,535,000	67,996,000	5,733
117. Standard Ohio	219,600	219,600	335,159	335,159	98
118. Summit Energy	8,698	8,698	4,853	4,853	6
119. Sun Co.	1,679,000	2,085,000	2,826,000	23,867,000	1,603
120. Sundance Oil	14,141	34,634	123,375	645,792	41
121. Superior Oil	561,000	1,377,000	1,305,000	18,749,000	488
122. Supron Energy	255,000	255,000	1,050,000	1,078,000	82
123. Tejas Gas	3,305	3,305	6,389	6,389	1
124. Tenneco	572,519	689,856	3,217,203	3,902,012	834
125. Texaco Inc.	2,183,000	4,948,000	7,115,000	93,728,000	18,636
126. Texas American Oil	40,289	40,289	212,816	212,816	12
127. Texas Eastern Corp.	64,259	154,610	540,000	899,000	338
128. Texas Gas Transmission	58,391	58,391	491,196	491,196	46
129. Tipperary Corp.	24,284	24,284	632,752	632,752	8
130. Tomlinson Oil	9,053	9,053	45,946	45,946	1
131. Total Petroleum N.A.	632,507	1,483,497	0	1,992,572	80
132. Transcontinental Oil	43,212	43,212	108,241	108,241	4
133. Transco Companies	52,401	52,401	136,543	136,543	70
134. TransOcean Oil	35,169	35,701	2,348,541	2,407,933	57
135. Triton Oil & Gas	29,524	40,672	255,536	3,434,732	23
136. Union California	1,038,000	1,411,000	3,631,000	27,125,000	1,993
137. United Energy Resources	73,571	74,114	292,351	300,692	28
138. Universal Resources	40,100	40,100	257,608	257,608	9
139. Vanderbilt Energy	12,576	12,576	6,623	15,613	2
140. Wainoco Oil	25,305	107,076	100,528	1,327,281	29
141. Webb Resources	9,836	20,425	373,607	373,607	4
142. Wichita Industries	4,233	4,233	522,743	522,743	1
143. Williams Companies	16,322	16,322	1,359,549	1,359,549	36
144. Wiser Oil	110,626	110,626	181,900	200,400	22
145. Woods Petroleum	43,830	53,550	335,110	682,705	27
146. Worldwide Energy	41,800	67,500	78,000	123,400	11
TOTAL	43,591,812	81,169,858	196,207,100	1,220,238,282	120,255

*Natural gas converted to oil equivalent: 6 Mcf = 1 bbl. ¹U.S. and Canada. ^eOur estimate.

Foreign acreage under exploration contracts (for the 146) total 1162 million acres. This large sum is important because operations are not so limited abroad as they are in the U.S.

Getting a concession to drill in a foreign country is not cheap, though, and can be very complicated. To get permission to conduct seismic exploration, a company has to pay the government for the concession and come to an agreement on how many wells will be drilled over what period of time and how much money will be spent for exploration.

After all that, if the company actually finds oil or gas, it probably shares production with the owner-government. And any remaining production may eventually be nationalized by the government.

This is the first table gathered showing so many individual company holdings and this list is not exhaustive.

An investor will be wise to learn the amount of producing and undeveloped acreage any company owns before committing capital.

Oil and gas reserves for each concern (last column) are shown in million barrels of oil equivalent, a total of foreign and domestic for each concern.

There is one clear fact — a company without acreage can't move far in the business of oil/gas exploration and production.

Average acreage for the 146 companies is 1.6 million acres in the U.S. and 8.0 million acres in foreign lands.

One reason for Texas Oil & Gas Corp.'s sharp rise is that the company has increased its undeveloped acreage each year since 1971—from 153,000 net acres to 4.4 million net acres in 1978.

Those companies with more than 10 million leased acres undeveloped are Amerada Hess, Atlantic Richfield, Cities Service, Conoco, Delhi International, Exxon, Getty, Gulf, Marathon, Mobil, Murphy, Natomas, Phillips, Shell, Standard California, Standard Indiana, Sun, Superior, Texaco and Union California.



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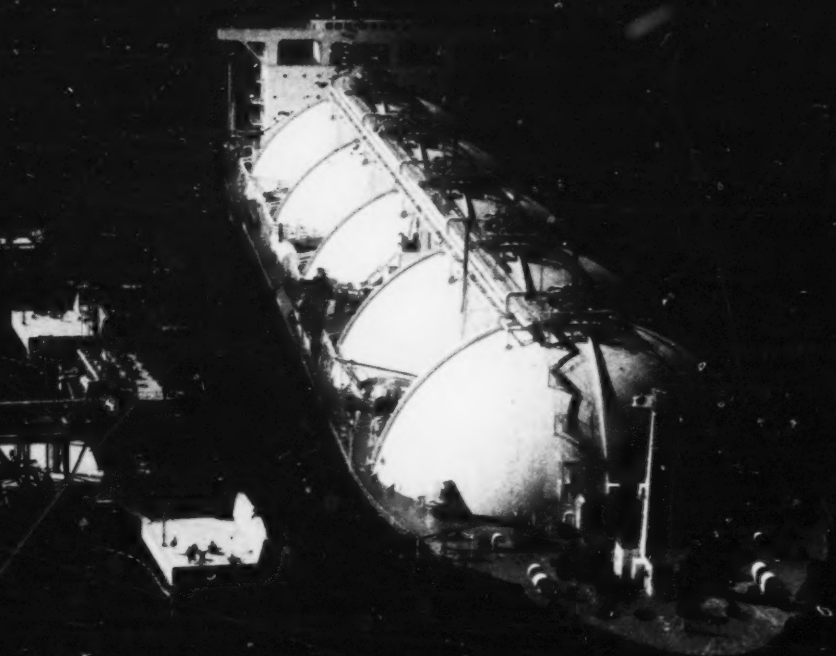
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Developments Proceed Slowly In International LNG Industry 17

More regulation of the LNG industry is promised as result of the Pipeline Safety Act of 1979 that mandates the DOT secretary to establish "minimum safety standards" for new LNG facilities in the U.S. — while LNG prices continue to escalate — and development of new LNG supplies continues to slow down. Major LNG activity appears in the making for Europe, Japan, and Southeast Asia.

LNG Scorecard 20

Details on LNG projects around the world are given in P&GJ's exclusive tabulation of LNG facilities in operation, under construction, or planned.

How Osaka Gas Uses LNG Cold 23

Osaka Gas Co., which will be regasifying about 6.3 million tons annually of LNG, has extensive plans to utilize the cold available in LNG that will effectively use that energy, help the company make money, and diversify the company's activities; LNG cold will be used for power recovery, ammonia synthesis, desalination, air separation, food freezing and storage, cryogenic crushing, and related operations.

Steady Growth Seen In Next Decade For World LNG Trade 39

Between now and the mid-1980's, size of world trade in LNG may well more than double — at an annual growth rate of about 16% (compared to a 23.5% annual growth rate of the past 15 years); here's complete tabulation of what to expect, what might happen.

Energy Conservation Pays 46

Dow Chemical's Midland Division uses more than 140 miles of overhead and underground piping in sizes to 36-in. to distribute utilities over a 1600-acre site.

Alaskan Gas Line Planning Team An Elite Group Of Arctic Experts 54

Members of the team assembled to design, build, and operate the Alaska Highway Gas Pipeline Project have more experience and Arctic working expertise than any group in North America — and they are now in the final design phases of the world's largest construction project.

Gas Pipeline Company Equipment Operators Get Hands-On Training 62

Learning by doing, rather than learning from a book, is the popular method in vocational training today — and Kansas-Nebraska Natural Gas Co. is teaching its transmission department employees to operate heavy equipment "hands on."

Intricate Connection In Charlestown 66

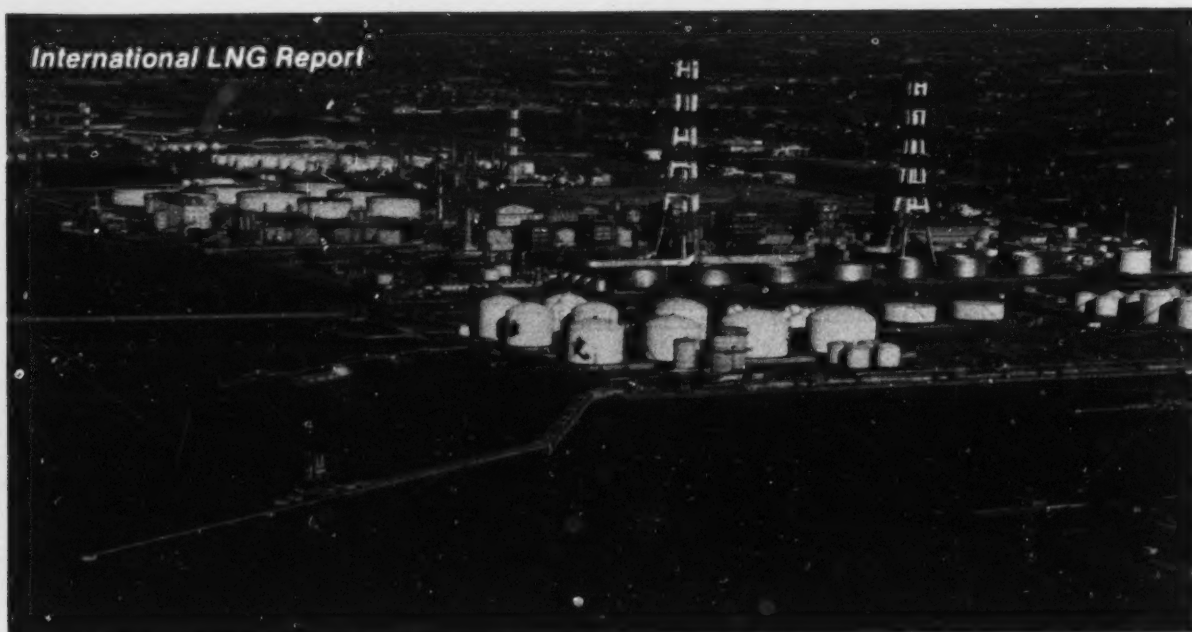
When Boston Gas Co. planned a repair in the Charlestown area amidst busy traffic in a street congested with other utilities, it was a project that required careful timing and carefully coordinated effort.



THE COVER

LNG Aquarius docked at Semboku II terminal of Osaka Gas Company, Osaka, Japan.

— Photo courtesy General Dynamics, Quincy Shipbuilding Division.



Semboku II Terminal at Osaka Gas Co.'s LNG import complex contributes to the volume of international LNG trade — which grows, albeit slowly, despite stringent regulatory policies, rising inflation, and burgeoning bureaucracy worldwide.

Developments Proceed Slowly In World LNG Industry

by Dean Hale, Editor

Despite considerable activity by companies and government regulatory agencies involved, little tangible progress has been seen on proposed LNG baseload projects around the world. Current operations have been characterized by their high performance, certainly, but even this has been marred in spots by shipping and operations mishaps.

U.S. Developments

On November 30, President Carter signed into law the *Pipeline Safety Act of 1979*, which amends the *Natural Gas Pipeline Safety Act of 1968* and includes regulation for LNG facilities under Title I — Natural Gas. The Act requires the Secretary of Transportation to establish minimum safety standards for siting, design, installation, construction, initial inspection, and initial testing of any new LNG facility. Contingency plans to be implemented at new facilities must also be prepared.

Facilities for which applications were filed for siting, construction, and operation at Federal, state, or local

levels prior to March 1, 1978 are "grandfathered" under this legislation.

The standards will apply to replacement components for existing facilities, but only if these will render them compatible with other existing components or would not otherwise be impractical. The Secretary is also required to conduct a study of the risks involved in LNG and LPG operations and of methods for assuring adequate financial responsibility by owners and operators. The results of these studies are to be transmitted to Congress for action. The legislation represents a compromise, favorable to the industry, of Senate S.411 and House H.R. 51 — legislation passed last summer.

The Secretary of Transportation, through the Materials Transportation Bureau, has now issued *LNG Facilities: Federal Safety Standard*, under CFR Part 193 for subparts covering siting, design, and construction.

The National Fire Protection Association issued a 1979 edition of its Standard 59A (Standard for the Production, Storage, and Handling of

Liquefied Natural Gas) in November. The new edition contains several significant additions in the areas of siting, design, and construction.

At the project level, the Federal Energy Regulatory Commission issued its order on rehearing of the applications to transport LNG from Alaska and Indonesia to California (Pac-Alaska and Pac-Indonesia Projects) and to build and operate a terminal at Little Cojo, near Point Conception, Calif. Subject to minor modifications and clarifications, FERC's October 12 order on the applications was reaffirmed and rehearing denied.

Petitions were filed subsequently by Bixby Ranch Co., the Holister Ranchowners' Association, and the Sierra Club with the U.S. Court of Appeals for the District of Columbia Circuit for review of the FERC orders. The Economic Regulatory Administration had completed action on its part of the regulatory procedure with its Opinion No. 8, issued on September 26. Required seismic studies at Little Cojo and related activities are underway by project partners.



LNG supertankers, such as Gotaas-Larsen, Inc.'s *Golar Freeze*, have helped worldwide LNG trade to attain remarkable annual growth.

LNG Pricing

After many months of negotiations, El Paso Natural Gas Co. agreed to modifications in the Contractual Sales Price Provisions of its October 9, 1969, contract with Sonatrach. The new provisions brought the F.O.B. pricing for the El Paso I project in line with subsequent Algerian contracts. Change was required because the original contract with a then-current F.O.B. price of about \$0.37 per million Btu resulted in a negative cash flow for Sonatrach. The new (July 1979) base sales price of \$1.75 per million Btu will escalate with changes in No. 6 and No. 2 fuel oils. The calculated contract sales price was discounted by \$0.60/million Btu initially to decrease to zero after June 30, 1983.

ERA approved an interim price in August for the period to December 31 for importers Columbia LNG Corp., Consolidated System LNG Co., and Southern Energy Co. On December 30, ERA approved the revised price of \$1.945 per million Btu for the period January 1, 1980, to June 30, 1980, with subsequent changes as provided in the supply contract, which has another 23 years to run. Adding ocean transport and revaporization costs would bring the current price to \$3.43/million Btu at the point where the fuel enters the pipeline. In its approval, ERA noted that the 1-billion-cu-ft-per-day gas

supply is still cheaper than other imported gas, including that from Mexico and Canada.

The ERA conditioned its approval of the new price by requiring that this LNG supply be incrementally priced to certain industrial end-users under the provisions of Title II of the Natural Gas Policy Act (NGPA). Explaining the rationale behind its incremental pricing decision, the ERA said: "Because of the substantial increase in the price of this gas occasioned by the Amendment Agreement [between El Paso Algerian and Sonatrach], we find that continuing to roll-in the price of this gas with other pipeline supplies would result in the subsidization of this LNG import at the expense of more secure sources of domestic natural gas and would tend to delay the conversion of industrial users of natural gas to coal and other domestic alternative fuels, contrary to the long-term energy interests of the nation."

Interestingly, the Algerian Parliament has asked for an investigation of why the price was not raised prior to this.

LNG Accidents

Involved in the El Paso I project, *El Paso Paul Kaiser* ran aground while on a loaded voyage off Gibraltar on June 29. The vessel was stranded during a maneuver to avoid a fishing ves-

sel crossing her bow. After *Kaiser* was refloated and towed to a sheltered anchorage, her sister ship, *El Paso Sonatrach*, moored alongside and the cargo of approximately 90,000 m³ was transferred. Lightering through a single flexible hose took about 48 hours and was accomplished without difficulty. *El Paso Sonatrach* unloaded the cargo at Cove Point in July. The LNG was still well within specifications. Although extensive damage was done to the ship's structure in the grounding, no LNG was released. Repairs at Chantiers de France's Dunkerque yard, estimated to cost about \$10 million, are expected to be completed in May.

With the Avondale LNG ships delayed due to problems with the insulation/secondary containment system, El Paso has been chartering Algerian flag vessels from Sonatrach and other laid-up vessels, such as Gotaas Larsen's *Golar Freeze* and the former Gazcocean ship *Ben Franklin*. Reportedly it is the quantity of LNG produced at the GLI-Z plant at Bethioua, Algeria, not shipping unavailability or terminal capacity, that limits project deliveries.

On October 6, an explosion occurred at the motor control center in an electrical substation at Cove Point Terminal. The explosion resulted from natural gas that leaked into the building

through electrical conduit connecting one of ten second-stage LNG pumps. No damage was done to any LNG-containing equipment and no LNG was released. Columbia LNG and federal and state agencies investigated the accident. FERC approved temporary recertification of the facility for interim repair construction. The facility was able to vaporize about 150-million-cu-ft-per-day by October 19, about 250-million-cu-ft-per-day in mid-November, and 500 million cu ft per day by the beginning of December. The 500-million-cu-ft-per-day capacity authorized by FERC enabled Cove Point to receive all of the cargo that would have been received had the accident not occurred.

New LNG Supplies

New U.S. baseload supply contracts that were expected to be announced in the last nine months are still pending. The Trinidad and Tobago project involving Peoples Gas and Tenneco subsidiaries for a nominal 600-million-cu-ft-per-day is still in negotiation.

Nigeria's Bonny LNG has reportedly modified its project to deliver half of the 1.6-billion-cu-ft-per-day to European rather than U.S. customers. Announcement of signed contracts by U.S. customers for their 800-million-cu-ft-per-day share is reported imminent.

European Developments

In mid-May, the Belgian government approved construction of the S.A. Distrigaz terminal at Zeebrugge. Due to delays in gaining approvals and during harbor expansion, the terminal is not expected to be completed before late 1985. Because the take-or-pay contract goes into effect with Algeria in the second half of 1982, an alternative delivery point will be required. Reportedly, this will be Gas de France's Montoir terminal, through gas delivery by displacement.

Algeria's GL2-Z liquefaction plant nears completion, its first production currently scheduled for midyear. LNG will be delivered to France at Montoir and to the U.S. at Trunkline LNG's Lake Charles terminal. Montoir is on schedule for a mid-year 1980 completion, but manpower shortages of skilled labor and bad weather have caused a five month slippage at Lake Charles. Delivery dates for the General Dynamics' ships *Lake Charles* and *Louisiana*, have been slipped correspondingly.

Considerable speculation has developed over Algeria's LNG plans involving Sonatrach's GL3-Z plant at Bethioua. Construction at the site was reportedly stopped in late September. Whether the halt represented a termination or just a delay while prepar-

ing design specifications for the LNG storage tanks is not known.

Concern over the potential effects of a catastrophic tank failure at one of the plants in the Industrial Zone is evidenced by Sonatrach's having sponsored a seminar on LNG/LPG storage in September. Sonatrach pointed to the significant investment represented in the Zone in terms of capital (\$6 billion by 1985), trained manpower (13,000 in 1985), and foreign exchange earnings (\$7 billion in 1985). Some form of "double integrity" storage plus additional security and fire protection provisions will undoubtedly be incorporated by the requirements. Technip-Snamprogetti, the process contractor, is winding the spiral heat exchangers for the nine trains each to have approximately 200 million cu ft per stream-day capacity. Most recent information is that the facility will be built, but about a year after the original startup date.

Concern over safety for LNG and LPG storage has been given new emphasis. In September, N. J. Cuperus, of Shell International Petroleum, presented a paper at the Tenth World Petroleum Congress entitled "Cryogenic Storage Facilities for LNG and NGL." The paper presented a two-tank configuration concept, based on the assumption that small spills due to leaks are possible, and, that the conceivable failure of the inner tank is due to brittle failure. These configurations, then, would provide that a spill resulting from a conceivable, inner-tank failure will be contained by a second, independent tank ("double integrity").

Double integrity is being incorporated in designs for LNG terminals such as DFTG's at Wilhelmshaven, West Germany, and N.V. Nederlandse Gasunie's at Eemshaven, The Netherlands. DFTG chose Dykerhoff Widmann - CMP as contractor for its four 60,000-m³ tanks, and Gasunie reportedly will select a contractor for its three 80,100-m³ storage tanks in the near future. Construction of these terminals to receive LNG from Sonatrach's GL3-Z plant apparently have been delayed to phase with delays in construction of the export facility.

Asian Developments

Contractors selected by Malaysia LNG SDN. BHD. for construction of the LNG plant at Bintulu included Pullman Kellogg and Japan Gasoline Co., Ltd., for process design and general contracting, and Toyo Kanetsu K.K. for the LNG tanks. Air Products & Chemicals Inc. will supply the cryogenic heat exchangers for the propane-stage mixed-refrigerant cycle. Most of the remaining components will come from Japanese suppliers, as will engineering services.

Tokyo Electric Power Co., Ltd., and Tokyo Gas Co., Inc., reportedly approach agreements to purchase all the LNG. The 20-year contract is reported to call for delivery of about 312 billion cu ft per year - the output of the plant's three liquefaction trains. Deliveries are scheduled to begin in 1983 and reach a level of 88 billion cu ft per year by 1985, prior to full deliveries' beginning in 1986.

The Australian government issued export permits for North West Shelf gas in anticipation of signed contracts. Export of approximately 930 million cu ft per day is expected to begin in mid-1986. Japanese customers are reported to be completing purchase agreements for the gas supply. Total cost of the project has risen to an estimated \$4.5 billion, several times the original estimate made in the mid-1970's.

Still in the about-to-be completed category is Pertamina's supply contract with Japanese customers, to result in a doubling of the Bontang Bay, East Kalimantan plant operated by P. T. Badak Natural Gas Liquefaction Co.

Potential Supply Sources

Based on accounts of recent offshore discoveries by European and U.S. companies, primarily in the northern coast area adjoining eastern Nigeria waters, speculation is that The Cameroons may become an LNG exporter. Major discoveries have been made by France's Elf Serepca and U.S. Shell's Pecten Cameroun and by a consortium of Mobil, Total, Ocelot, and Damson Oil. Total recoverable gas reserves of the Cameroon fields could be from 4 to 7 trillion cu ft, which would be enough to warrant a 500-to-750 million-cu-ft-per day export project. Developmental drilling to prove up reserves is reportedly planned for these permits, along with additional exploration drilling.

Although Argentina now imports Bolivian gas, its energy secretary has stated that his government will investigate gas export project possibilities. According to the energy secretary, the export options include LNG, pipeline export to neighboring countries, and use of feedstock for petrochemical export. Argentina is also expanding domestic consumption of gas to displace imported hydrocarbon liquids. Under recent agreement, N. V. Nederlandse Gasunie will head a consortium to build and manage a 2000-km (1200-mile) pipeline from the Neuquen and Mendoza fields to the Buenos Aires area. Gasunie will also assist in gas production and management of the gas distribution. A European banking group is arranging financing for the project, scheduled to begin deliveries in 1982.

P&GJ

SCORECARD

U.S. and Canadian LNG Peakshaving Facilities

March 1980

Company and Plant Site	Liquefaction Plant Capacity, MMcf/day	Storage Capacity, MMcf	Regasification—MMcf				Type of Storage Container	Storage Constructor	Liquefaction Plant Constructor	Type of Cycle	Year of Operation
			Design Capacity	Rate	No. of Days	Type					
APCI-NEGA Hopkinton, Mass.	19.5	2000 (2 x 250)	580	248	4 yr 62	Submrgd	Aboveground, 9% nickel	CBI	Cryo-Methane	Cascade	1967—plant, 1971 on new tanks, 1973—third tank
APCI-NEGA Hopkinton, Mass.	—	—	290	—	—	—	Aboveground, 9% nickel	CBI	—	—	1965
ALABAMA GAS CORP. Birmingham, Ala.	4.65	625	180	127/85	3 at 62.5	10	Submrgd	Aboveground, 9% nickel	CBI	Air Products & Chemicals, Inc.	1971—second tank
ALABAMA GAS CORP. Birmingham, Ala.	—	625	180	42.5	1 at 42.5	—	Submrgd	Aboveground, aluminum	CBI	—	1972
ALABAMA GAS CORP. Cosco, Ala.	2.7	600	175	80	2 at 40	15	Submrgd	Aboveground, aluminum	CBI	CBI	Modified Cascade
ATLANTA GAS LIGHT CO. Riverdale, Ga.	10.0	1000	290	200	3 at 190	5	Uniflux	Aboveground, aluminum	CBI	Air Liquide	TEAL
ATLANTA GAS LIGHT CO. Riverdale, Ga.	—	1500	450	—	—	—	Aboveground, 9% nickel	CBI	—	—	Process boost
ARKANSAS-MISSOURI POWER CO. Yarbro, Ark.	0.96	374 (2 x 55)	110	86	2 at 33	6	Direct	Aboveground, aluminum	Brown, Minneapolis Tank & Fab. Co.	Process Constructors, Inc.	1973—(1972 as satellite)
BALTIMORE GAS & ELEC. CO. Baltimore, Md.	2.75	500 (2 x 72.5)	145	187.5/125	3 at 62.5	5	Submrgd	Aboveground, aluminum	CBI	CBI	Expander
BALTIMORE GAS & ELEC. CO. PLANT No. 2, Baltimore, Md.	2.4	500	145	82.5	1 at 62.5	8	Submrgd	Aboveground, aluminum	CBI	CBI	MRL
BAY STATE GAS CO. Ludlow, Mass.	7.5	1000	290	55	1 at 25	20	Uniflux	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO
BOSTON GAS CO. Boston, Mass.	6.8	1000	290	187.5/125	3 at 62.5	8	Submrgd	Aboveground, 9% nickel	CBI	CBI	Expander
BOSTON GAS CO. Boston, Mass.	—	1120	301	—	—	—	Aboveground, aluminum	CBI	—	—	1971—second tank
BOSTON GAS CO. Lynn, Mass.	7.85	1000	290	86.4/57.6	3 at 28.8	12	Submrgd	Aboveground, 9% nickel	PDM	Air Products & Chemicals, Inc.	MCR
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY Vancouver, B.C.	2.5	625	180	150/100	3 at 50	6	Submrgd	Aboveground, 9% nickel	Pittsburgh Des Moines Steel	Air Liquide	TEALARC
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	5.68	625	175	100	2 at 50	4	Direct	Aboveground, 9% nickel	CBI	American Messer	Expander
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	—	1000	290	50	2 at 25	—	Direct	Aboveground, 9% nickel	CBI	—	1971—second tank
CHATTANOOGA GAS CO. Chattanooga, Tenn.	10.0	1200	348	90/60	3 at 30	26	Direct	Aboveground, 9% nickel	PDM	J. F. Pritchard	PRICO
CITIZENS GAS & COKE UTILITY Beech Grove, Ind.	5.0	1000	290	180	3 at 60	5	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC
COMMONWEALTH NATURAL GAS CO. Tidewater, Va.	5.0	1200	348	105	3 at 35	12	Direct	Aboveground, 9% nickel	PDM	Envirogenics	Cascade
CONNECTICUT NATURAL GAS CORP. Rocky Hill, Conn.	6.6	1200	348	80/55	2 at 25	24	Vapor Trsftr	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/Nitrogen
CONSOLIDATED EDISON CO. Astoria, N.Y.	8.0	1000	290	300/240	5 at 60	4	N.A.	Aboveground, 9% nickel	PCAM	Airco Cryoplants	Expander/Nitrogen
DEL MARVA POWER & LT. CO. Wilmington, Del.	1.71	250	72.5	50	2 at 25	5	Direct	Aboveground, aluminum	CBI	Lotepro-Linde AG	Expander/Nitrogen
EAST TENNESSEE NATURAL GAS CO. Fortdon, Tenn.	5.5	1200	348	150	2 at 75	8	Direct	Aboveground, aluminum	CBI	CBI	MRL
ENERGY TERMINAL SERVICES CORP. Staten Island, N.Y. (Conversion of part of terminal capacity to peakshaving. Uses one of two storage tanks and all of vaporization capacity.)	15.0	3000	900	360	4 at 90	8	Direct	Prestressed concrete	Printhead/Walsh	NA	NA
FALL RIVER GAS CO. Fall River, Mass.	0.5	150	45	10	1	15	Direct	Aboveground, 9% nickel	PDM	CVI Corp.	Dual J. T. Cycle
GAS LIGHT CO. OF COLUMBUS Columbus, Ga.	1.7	500	145	60	2 at 30	8	Indirect	Aboveground, aluminum	CBI	CBI	Expander
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	10.0	1000	290	180	3 at 60	18	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	—	1000	290	—	—	—	Aboveground, 9% nickel	Horton (CBI)	—	—	1972—second tank
INTERMOUNTAIN GAS CO. Boise, Idaho	4.0	600	175	90/60	3 at 30	10	Submrgd	Aboveground, aluminum	PDM	Lotepro-Linde AG	Expander/Nitrogen
IOWA-ILLINOIS GAS & ELEC. CO. Bettendorf, Iowa	2.0	500	145	50	2 at 25	10	Uniflux	Aboveground, aluminum	CBI	CBI	MRL
IOWA POWER & LT. CO. Des Moines, Iowa	2.0	400	116	30	2 at 15	13	Intermed.	Aboveground, aluminum	CBI	CBI	MRL
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	2.5	400	117	30	2 at 15	26	Intermed.	Aboveground, aluminum	PDM	APCO (grime) Air Liquide (liquefaction)	TEALARC
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	—	400	117	—	—	—	Aboveground, aluminum	CBI	—	—	1978—second tank
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.3	400	116	30/15	2 at 15	28	Direct	Aboveground, aluminum	CBI	CBI	MRL
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.25	—	—	—	—	—	(Second liquefaction unit)	CBI	CBI	CBI	MRL
LONG ISLAND LIGHTING CO. Holbrook, N.Y.	3.0	600	175	200/150	4 at 50	4	Submrgd	Aboveground, 9% nickel	PDM	Lotepro-Linde AG	Cascade/Mixed Refrigerant
LOWELL GAS CO. Lowell, Mass.	4.5	1000	290	70/70	2 at 30	18	Direct	Aboveground, 9% nickel	Graver/Envirogenics	Envirogenics	Expander
MEMPHIS LIGHT, GAS & WATER DIV. Memphis, Tenn.	5.0	1000	290	201	3 at 67	5	Submrgd	Aboveground, 9% nickel	CBI	Air Liquide	Cascade
METRO UTILITIES DISTRICT Omaha, Neb.	6.0	1000	290	60/30	2 at 30	33	Submrgd	Aboveground, 9% nickel	CBI	Lotepro-Linde AG	Expander/Nitrogen
MINNESOTA GAS CO. Burnsville, Minn.	5.0	1000	290	80	2 at 40	12	Intermed.	Aboveground, 9% nickel	CBI	CBI	MRL
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Direct	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Submrgd	Aboveground	CBI	Lotepro	Mixed Refrigerant
NORTHERN & CENTRAL GAS CO. Hager, Ontario	2.5	625	180	85	3 at 42.5	7	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC
NORTHERN & CENTRAL GAS CO. Hager, Ontario	—	—	—	—	1 at 42.5	—	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Lotepro Engr.	—
NORTHERN NATURAL GAS CO. Wendell, Minn.	10.0	2185	630	200	2 at 100	10	Submrgd	Aboveground, 9% nickel	PDM	SD Plants	TEALARC
NORTHERN NATURAL GAS CO. Ventura, Iowa	14.5	2185	630	300	3 at 100	7	Submrgd	Aboveground, 9% nickel	PDM	NAG	PRICO
NORTHERN STATES POWER CO. East Chalm, Wisc.	2.0	270	78	24/24	2 at 12	11	Direct	Aboveground, aluminum	CBI	CBI	Expander
NORTHERN STATES POWER CO. Wesport, Minn.	10.0	2000	580	75	2 at 37.5	28	Direct	Aboveground, 9% nickel	CBI	CBI	MRL
NORTHWEST NATURAL GAS CO. Portland, Ore.	2.5	625	175	200	2 at 60	10	Direct	Aboveground, aluminum	CBI	CBI	Expander
NORTHWEST NATURAL GAS CO. Newport, Ore.	5.0	1200	348	100/100	2 at 50	12	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL/CRYEX
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	225	3 at 75	8	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	75	1 at 75	15	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC
PEOPLES GAS, LIGHT & COKE Fisher, Ill.	10.0	2000	580	300/200	3 at 67	10	Direct	Aboveground, aluminum	CBI	CBI	Expander
PHILADELPHIA ELECTRIC CO. West Conshohocken, Pa.	6.6	1200	348	310/186	5 at 62	4	Submrgd	Aboveground, 9% nickel	CBI	Airco Cryoplants	Expander/Nitrogen
PHILADELPHIA GAS WORKS Philadelphia, Pa.	25.0	4000 (2 x 583)	500/400	5 at 100	10	Intermed.	Aboveground, Prestressed concrete	Printhead	J. F. Pritchard	Cascade	1969—Plant operable, 1974 on tanks
PIEDMONT NATURAL GAS CO. Charlotte, N. Car.	5.0	1000	290	150	3 at 50	7	Direct	Aboveground, 9% nickel	CBI	CBI	MRL

Import/Receiving Terminals

March 1980

Company and Plant Site	Storage Capacity Mbl	Capacity Mbl	Regasification—Mbl/Day Type	Type of Storage Container	Storage Contractor	Receiving Contractor	Year of Operation
BRITISH GAS CORP. Canvey Island, England	4000 1400	1200 382 (8 - 60 + 2 - 16)	3 at 50 1 at 50 2 at 50	Submerg. Seawater Intermediate fluid/seawater	Frozen hole Aboveground, aluminum	Conciv McAlpine APV and Whessoe	1958, 1963, 1967
GAZ DE FRANCE Monteur de Bretagne	5300	1512 (2 x 756)	4 at 228	Estuary waller	Aboveground, concrete	Chantiers Modernes, Europe Etudes Technicar, Bignier-Schmidt-Laurent CBI Inc.	1980—U.C.
GAZ DE FRANCE Le Havre, France	752	229.5 (3 x 76.5)	3 at 25	Seawater Fluid	Aboveground, 9% nickel		1963
GAZ DE FRANCE Fos-Sur-Mer, France	1500	430 (2 x 225)	4 at 106	Intermediate Fluid	Aboveground, aluminum	CBI Inc.	1971
GAZ DE FRANCE Fos-Sur-Mer	1000	290			Aboveground, 9% nickel	C.M.P.	1979—third tank
ENAGAS S.A. Barcelona	1800	500 (2 x 250)	1 at 67 2 at 67	Seawater Submerg.	Aboveground, concrete	Preload/Christian and Nelson	1969
	1800	500	2 at 67	Seawater submerg.	Aboveground, 9% nickel	Falguera Provence CBI	1974
	1800	500	4 at 134	Seawater	Aboveground, concrete	Preload Auzan	1979 U.C.
SNAM (ERI) La Spezia, Italy	2100	630 (2 x 315)	2 at 1765	Intermediate Fluid	Aboveground, concrete	SAIPEM (POM Inc.)	Esso R&D
N.V. NEDERLANDSE GASUW, Groningen, Groningen, The Netherlands	5300	1512 (3 x 504)	N.A.	Combination seawater/ submerg. possibly cold energy/recovery seawater	Aboveground, concrete and 9% nickel	N.A.	1984—Planned
DEUTSCHE FLUSSGAS GAZ TERMINAL GmbH Wilhelmshaven, Ger.	5300	1508 (4 x 377)	16 at 135	Submerg. seawater	Aboveground, concrete and 9% nickel	Dyckerhoff Widmann — CMB	1983—Planned
DISTRIGAZ S.A. Zeebrugge, Belgium	9072	2520 (4 x 630)	10 at 100	Submerg.	Hall	N.A.	1986—Planned
TOKYO GAS CO./TOKYO ELECTRIC, Negishi, Yokohama, Japan	3480	1030 (2 x 284)	4 at 56 1 at 56	Seawater Submerg.	Aboveground, 9% nickel	IHI	Tokyo Gas Co.
	219	63 (2 x 221)	1 at 56	Submerg.	Inground concrete and SUS membrane	IHI	1970
	1287	378			Inground concrete and SUS membrane	IHI	1972
	979	284 191	1 at 93 1 at 49 1 at 49	Seawater Seawater Submerg.	Aboveground, 9% nickel	IHI	Tokyo Gas Co.
	544	158			Aboveground, 9% nickel	IHI	1973
	2038	599 110	1 at 110	Submerg.	Inground concrete and SUS membrane	IHI/Kajima	Tokyo Gas Co.
	2038	599 110	1 at 110	Submerg.	Inground concrete and SUS membrane	IHI/Kajima	1977
	2038	599 110	1 at 110	Seawater	Inground concrete and SUS membrane	Nippon Kokan	Tokyo Gas Co.
	2038	599 110	1 at 110	Seawater	Inground concrete and SUS membrane	Kawasaki Heavy Industries	1979 1981 (U.C.)
TOKYO GAS CO./TOKYO ELECTRIC, Sodegaura, Chiba, Japan	1931	568 (2 x 284)	3 at 66 2 at 66	Seawater Submerg.	Aboveground, A1 IHI	Tokyo Gas Co.	1973
	1287	378 110	3 at 66 4 at 55	Seawater Seawater	Aboveground, A1 Inground concrete and SUS membrane	IHI	Tokyo Gas Co.
	2574	756 (2 x 378)			Aboveground, A1 Inground concrete and SUS membrane	IHI	1974
	1931	568 (2 x 284)			Aboveground, A1 Inground concrete and SUS membrane	IHI	1974
	2574	756 (2 x 378)			Aboveground, A1 Inground concrete and SUS membrane	IHI	1975
	1287	378 110	2 at 110 1 at 60 1 at 60	Seawater Seawater Submerg.	Inground concrete and SUS membrane	IHI	Tokyo Gas Co.
	2574	756 (2 x 378)			Aboveground, A1 Inground concrete and SUS membrane	IHI	1977
	5148	1512 (4 x 378)	2 at 110 2 at 131 1 at 131	Seawater Seawater Submerg.	Inground concrete and SUS membrane	IHI	Tokyo Gas Co.
	2574	756 (2 x 378)			Inground concrete and SUS membrane	Kajima-MHI	1977
	1330	756 (1 x 381) (1 x 365)			Inground concrete and SUS membrane	IHI	1979
	2574	756 (2 x 378)			Inground concrete and SUS membrane	Kajima-MHI	1979
	1287	378			Inground concrete and SUS membrane	Kajima-MHI	1981 (U.C.)
	5578	1640 (2 x 820)			Inground concrete and SUS membrane	MHI-Kajima IHI-Shimizu	1982 (U.C.)
OSAKA GAS CO. Semboku I, Osaka, Japan	3920	1130 (1 x 280— underground) (3 x 280— aboveground)	3 at 40 1 at 40	Seawater Intermediate Fluid	Aboveground, aluminum (1) 9% nickel (2)	IHI/Ohtayashi	Osaka Gas
OSAKA GAS CO. Semboku II, Osaka, Japan	16,298	4700 (10 x 470)	7 at 60 2 at 60	Seawater Thermal Fluid	Aboveground, aluminum (3) 9% nickel (7)	IHI and Toyo Kanetsu K.K.	Osaka Gas
KITA KYUSU LING CO. Tobata, Fukuoka, Japan (Kyusuu Electric/Nippon Steel)	7722	2268 (6 x 378)	4 at 112 1 at 110	Seawater Submerg.	Aboveground, 9% nickel	IHI Toyokanetsu	IHI
CHUBU ELECTRIC/TOHO GAS CO. Chita, Aichi, Japan	3218	1892 (2 x 473)	1 at 142 3 at 142 1 at 88 4 at 22	Seawater Seawater Submerg. Seawater	Aboveground, A1 Aboveground, 9% Nickel	IHI Toyokanetsu	IHI
KANSAI ELECTRIC/OSAKA GAS Himeji, Hyogo, Japan	2995	1781 (3 x 503)	1 at 22 5 at 125	Seawater	Aboveground—2 tanks Aluminum—1 tank	IHI	IHI
ALGOSOLIN LING INC. Providence, R.I.	6000	1800 (3 x 600)	3 at 100	Direct Fluid	Aboveground, 9% nickel	CBI	CBI
COLU/BIA LING CORP. & CONSOLIDATED SYSTEM LING CO., Cove Point, Maryland	5000	1500 (4 x 375)	3 at 125 10 at 100 2 at 100	Seawater Intermediate Fluid	Aboveground, aluminum	POM	Pulman Kellogg & Raymond Technical
DISTRIGAS CORP. Everett, Wash.	3250	974 (1 x 374 + 1 x 600)	3 at 45	Submerg.	Aboveground, 9% nickel	CBI	CBI
EL PASO LING TERMINAL CORP. Port O'Connor, Texas	6854	1890 (3 x 630)	10 at 105	Seawater	Aboveground	N.A.	N.A.
NATURAL GAS PIPELINE CO. OF AMERICA (Peoples Gas) Ingleside, Tex.	6804	1890 (3 x 630)	11 at 104	Seawater Submerg.	Aboveground, 9% nickel	N.A.	1980's—Planned
SOUTHERN ENERGY CO. Ella Island, Ga.	4000	1200 (3 x 400)	5 at 108	Submerg.	Aboveground, aluminum	Cui	Bechtel Inc. and Raymond Technical
TRUNKLINE LING CO. Lake Charles, La.	6000	1800 (3 x 600)	7 at 100	Submerg.	Aboveground, 9% nickel	POM	Pulman Kellogg Co. and Raymond Technical
WESTERN LING TERMINAL CO. Little Cajo, Calif.	5775	1650 (3 x 550)	12 at 100	Direct seawater	Aboveground, 9% nickel	N.A.	1984—Planned

International LNG Report

Steady Growth Seen In Next Decade For World Trade In LNG

by P. J. Anderson, *Contributing Editor*

By 1979, international trade in LNG had grown from an initial contractual level of 150 million cu ft per day to a level of 4.482 billion cu ft per day, which represents a 30-fold increase in the last 15 years. Deliveries in 1978 amounted to approximately 2.525 billion cu ft per day. Because two new projects were coming on-stream in 1978, deliveries actually approached 75% of anticipated quantities rather than the apparent level of 56%. Although many projects did deliver at contract quantities, several were plagued by technical problems with the liquefaction and transportation segments of the chain. The number of LNG-exporting countries also has increased from one to six in the intervening 15 years.

Those who have not been part of this industry during the last 20 years might conclude that 23.5% annual growth rate is truly remarkable and worthy of great praise. So it is! It is praiseworthy not just because the LNG trade has reached its originally projected goals, but because of the determination of its promoters in achieving this comparatively modest trading level. Original projections for LNG's future make its present achievements pale by comparison.

What, then, do the next 10 years hold for this industry? Based on past actual performance versus that projected, it appears that growth will continue at a slow pace, with a limited number of new exporters entering.

Between now and the mid-1980's,

the size of world trade in LNG could well be expected to more than double with the implementation of those trades considered to be "firm" or "under construction" (Table 3). These projects, which total 4.835 billion cu ft per day, represent a slowing of the annual growth rate to about 16%. Some of the projects involved are not as firm as might be desired.

By the time this article appears, a better definition may exist of the course of petitions filed with the U.S. Court of Appeals for the District of Columbia Circuit by the intervenors in the Pac-Indonesia and Pac-Alaska Projects. Also, results of seismic studies at the Little Cojo terminal site near Point Conception, Calif., should be further along, perhaps far enough

to assess the suitability of the site. Algeria's plans to construct and export LNG from its GL3-Z facility at Bethioua are not yet fully resolved. Although it appears probable that the facility will be constructed, implementation will be delayed for over a year.

If Algerian exports and U.S. imports from Indonesia and Alaska are not realized, some of these lost volumes might be made up by additional sales to Japan from Pertamina's North Sumatra, Indonesia, facility, as well as through the anticipated implementation of the expansion of the East Kalimantan, Indonesia, facility. The net effect would appear to be a decline in traded volume of about 3 billion cu ft per day. The remaining 1.8 billion cu ft per day in anticipated growth would correspond to an annual growth rate of just above 7%. The impact on the overall size of the industry of a single project or construction of a large export facility illustrates its relatively small size. Implementation of these firm projects will add Malaysia to the list of exporting nations.

Planned Projects

Several projects are in various stages of planning. The probability of their implementation varies from near certainty for the expansion of Pertamina's East Kalimantan facility to negligible for Chilean exports to the U.S. With the exception of the Indonesian project, none of these planned projects would appear likely to be implemented until the second half of this decade.

Those projects with a greater than 50% probability of implementation appear to be Pertamina's expansion for East Kalimantan, Nigeria, Algeria's German export, and Australia. Expansion of Pertamina's North Sumatra facility would appear to depend upon implementation of the U.S. import project.

Implementation of Arctic Island projects appears dependent upon several considerations including Canadian National Energy Board decisions, governmental policies, and the ultimate cost and reliability of arctic transportation. Exports to the United States either from Chile or the Soviet Union are politically unacceptable at this time.

To the list of projects with favorable odds for implementation could be added the project for Trinidad and Tobago. Here, agreement between participants on contracts necessary to implement a project is expected by year-end. Assigning probabilities and discounts leads to the conclusion that, by the end of this decade, another 3.5 billion cu ft per day of LNG projects could be implemented. Combined with the previously discussed projects that

TABLE 1
LNG Deliveries in 1978

Project	Ports	Volume, 10 ⁶ CF
1. Algeria — U.K.	Arzew — Canvey Island	28.93
1a. Algeria — France	Arzew — Le Havre	
	Skikda — Le Havre	
	Total	11.34
2. Libya — Spain	Marsa el Brega — Barcelona	41.36
2a. Libya — Italy	Marsa el Brega — La Spezia	84.48
3. Alaska — Japan	Kenai — Negishi	48.40
4. Algeria — Spain	Skikda — Barcelona	10.29
5. Algeria — France	Skikda — Fos Sur Mer	
	Arzew — Fos Sur Mer	
	Total	99.07
6. Brunei — Japan	Lumut — various Japanese ports (Semboku, Sodegaura, Negishi)	
	Total	266.67
7. Abu Dhabi — Japan	Das Island — Sodegaura	64.87
8a. Indonesia — Japan	Bontang — various Japanese ports (Semboku, Tobata, Chita)	
	Total	162.40
8b. Indonesia — Japan	Arun — various Japanese ports (Semboku, Tobata, Chita)	
	Total	19.25
9. Algeria — U.S.	Arzew — Cove Point	
	Arzew — Elba Island	
	Total	69.86
10a. Algeria — U.S.	Skikda — Everett	
	Arzew — Everett	
	Total	14.60

TABLE 2
Base-Load LNG Import Projects
(Currently Operational)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu ft
Algeria — United Kingdom	1964	15	CAMEL (SONATRACH)	100	2. United Kingdom	27,400
Arzew — Canvey Island			British Gas Corp. Conch International			
Algeria — France	1964	25	CAMEL (SONATRACH)	50	1. France	25,500
Arzew — Le Havre			Gaz de France			
Alaska — Japan	1969	15	Phillips Petroleum Co. Marathon Oil Co.	135	2. Sweden	71,500
Kenai — Negishi			Tokyo Electric			
Libya — Italy	1969	20	Esso Standard Libya SNAM	235	3. Italy	40,000
Marsa el Brega — La Spezia						
Libya — Spain	1969	15	Esso Standard Libya	110	1. Spain	40,000
Marsa el Brega — Barcelona						
Brunei — Japan	1972	20	Brunei LNG, Coldgas Trading	737	7. France	75,000
Lumut-Sodegaura — Negishi, Semboku			Osaka Gas, Tokyo Gas Tokyo Electric Power			
Algeria — France	1972	25	SONATRACH	350	2. France	40,000
Skikda — Fos s. Mer			Gaz de France			
Algeria — U.S.	1971	20	SONATRACH	115	1. France	1-125,300
Skikda — Everett			Alocean Distigas			
Algeria — Spain	1974	15	SONATRACH	450	1. NA	30,000
Arzew — Barcelona	(full delivery 1980)		Empress Nacional de Gas	(full delivery 150)	1. France	125,300
Abu Dhabi — Japan	1977	20	Abu Dhabi Liquefaction Co.	450	3. Norway	125,000
Das Island — Tokyo			Tokyo Electric Power		1. Norway	87,600
Indonesia — Japan	1977	20	Pertamina, Osaka Gas	1050	7. U.S.	125,000
North Sumatra, East Kalimantan — Japanese Terminals			Kansai Electric Power Chubu Electric Power Kyushu Electric Power Nippon Steel			
Algeria — U.S.	1978	20	SONATRACH	1000	3. France	125,000
Arzew — Cove Point, Elba Island			El Paso LNG Co. (Algerian Subsidiary) Columbia LNG Corp. Consolidated System LNG Co. Southern Energy Co.		6. U.S.	125,000

could be implemented during the first half of the decade, a growth rate for the 1980's of about 11% in LNG volume appears reasonable. During the second half of the decade Nigeria, Australia, Trinidad and Tobago, and possibly Canada could become LNG exporters.

Beyond 1990, several LNG export projects could be implemented. These

projects involve countries or regions with gas reserves large compared with indigenous requirements. The Middle East, West African countries such as The Camerons, and the Soviet Union are potential candidates for LNG projects. Some countries not included in this list might elect to expand existing projects depending upon the condi-

TABLE 3
Base-Load LNG Import Projects
(Firm or Under Construction)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Indonesia — U.S. North Sumatra — Little Cojo	1984	20	Pertamina — Mobil Pacific Lighting International S.A. Pacific Indonesia LNG Co. Western LNG Terminal Associates	550	2, France 1, France 6, U.S.	120,000 125,300 125,000
Algeria — Belgium Arzew — Zeebrugge	1982	20	SONATRACH Distrigas, S.A.	500	1, Belgium 1, NA	131,600 125,000
Algeria — U.S. Arzew — Lake Charles, La.	1980	20	SONATRACH Trunkline Gas Co. Trunkline LNG Co.	450	2, U.S. 2, French 1, French	125,000 129,500 125,000
Algeria — France Arzew — Montoir de Bretagne	1980	20	SONATRACH Gaz de France	515	1, French 1, NA	129,500 125,000
Malaysia — Japan Bintulu — Japanese Terminals	1983	20	Sarawak Petronas, Mitsubishi, Tokyo Gas, Osaka Gas, Tokyo Electric Power Co.	870	5, French	130,000
Algeria — Holland/ Germany Arzew — Wilhelmshaven, Eemshaven	1983	20	SONATRACH Ruhrgas Ag. N.V. Nederlandse Gasunie Salzgitter Ferngas	1150	5, NA	125,000
Algeria — Germany Arzew — Wilhelmshaven	1984	20	SONATRACH Thyssen AG Gewerkschaft Brigitta	400	2, NA	125,000
Alaska — U.S. Kenai — Little Cojo	1985	20	Pacific Alaska LNG Associates Western LNG Terminal Associates	Initial: 200 Total: 400	1, U.S. 2, U.S.	130,000

TABLE 4
Base-Load LNG Import Projects
(In Planning Stages)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Indonesia — Japan East Kalimantan — Japanese Terminal (plant expansion)	1983	20	Pertamina Osaka Gas Co Toho Gas Kansai Electric Chubu Electric	435	3, NA	125,000
Chile — U.S. Cabo Negro — U.S.	1984	20	Chilean Gas Ltd. Atlantic Richfield Co. Air Products and Chemicals, Inc.	230	3, NA	125,000
Nigeria — U.S.	1985	25	Bonny LNG, Ltd. U.S. and European Customers	1600	16, NA	125,000
Arctic Islands — Canada	mid 1980's	20	Alberta Gas Trunkline Petro-Canada Southern Companies	250	2, NA	140,000
Australia — U.S., Japan	1985	NA	Woodside Group Japanese Customers	850	7-14, NA	125,000
Algeria — Germany	1985	20	SONATRACH Deutsche BP	450	2, NA	125,000
Indonesia — Japan Arun — Japanese Terminals (plant expansion)	1985	20	Pertamina Japanese Customers	220	1-2, NA	125,000

tions existing at that time. It is not yet possible to predict with any reasonable degree of certainty what the economic and energy situation in a particular country will be. One can only be reasonably certain that the time required to implement a project will not become shorter, and may even increase if more hostile environments are involved.

During this decade, projects in ad-

dition to those cited are not likely to be developed. Some of the projects cited will undoubtedly be added to the already existing list of those that have been cancelled or are held in abeyance.

Future Developments

Against this listing of projected development of LNG trade in the next decade, what background factors may exist?

Energy needs are going to increase, resulting in a return to a positive growth rate of perhaps 2%. Petroleum's share should maintain its 65% to 70% of primary energy supply.

Whether natural gas can increase its relative share depends upon economic and political considerations. Pipeline transport of gas costs roughly twice that for crude oil; the cost of sea transport for LNG is between four

TABLE 5
Base-Load LNG Import Projects
(Under Consideration)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Trinidad and Tobago — U.S.	1985	20	Trinidad and Tobago Peoples Overseas, Inc. Tenneco Trinidad LNG	nominal 600	3, NA	130,000
U.S.S.R. — U.S.	1985-90	25	Occidental Petroleum Co. El Paso LNG Co.	1000	14, NA	125,000
U.S.S.R. — U.S. and France	1985-90	25	Brown and Root, Inc. Tenneco, Inc. Texas Eastern International Corp.	1500 U.S. 500 France	20, NA	120,000
U.S.S.R. — Japan	1985-90	NA	Japanese Consortium	1000	4, NA	125,000
Nakhodka — Japan	1986	25	Shell	750	9, NA	125,000
Qatar — Japan	1985	NA	Bridgestone Promigas Texaco	150	1, NA	40,000

TABLE 6
Base-Load LNG Import Projects
(Cancelled or Held in Abeyance)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Algeria — Sweden	1983	20	SONATRACH Swedegas	200	1, NA	125,000
Algeria — U.S.	1983	25	SONATRACH El Paso LNG Co.	1000	12, NA	125,000
Algeria — Canada, U.S.	1983	20	SONATRACH Tenneco LNG, Inc. Lornetenn LNG Ltd.	960	8, U.S.	125,000
Algeria — U.S.		20	SONATRACH EASCOGAS	600	3, U.S.	125,000
Iran — Japan	1983	25	National Iranian Gas Co. Japan Kaligas	400	2, NA 5, Japan	125,000
Iran — U.S.	1983	25	National Iranian Gas Co. Columbia LNG Corp. Consolidated LNG	300	6, NA	125,000
Iran — Japan, Europe	1983	25	National Iranian Gas Co. Japan Kaligas Chicago Bridge & Iron Co.	400	6, NA	125,000

and five times that for crude oil. Pricing policies set by exporters and importers are obviously critical. They may be established so as to compensate for these economic disadvantages.

One effect of pricing policies may be to provide an incentive to export gas for countries with substantial non-associated reserves. Others may question the rationale of exporting gas, with its attendant capital-intensive nature and low employment per dollar of capital investment, to replace uses currently supplied by liquid petroleum products.

The importer or importing country will have to continue sharing in the capital costs and risks involved in developing LNG projects. This will be necessary to ensure the profitability of projects, especially for lesser-developed countries with large populations.

Over the next decade, projects are likely to continue to be developed on long-term contractual bases because of their massive capital requirements. The size of projects may show a broader spread in the future. More projects in the 300-to-500-million-cu-ft-per day range may be implemented because of uncertainties in long-term market needs. This would open up additional potential supply sources, make financing easier, and provide a measure of supply security.

To accommodate smaller projects, it appears reasonable to anticipate that modular facilities may be utilized.

These facilities in various forms would speed construction, improve quality control, and reduce investment costs. The use of such facilities would be expected to have a positive effect on securing financing, since the risk of heavy financial charges for delayed commissioning and reduced reliability would be lessened.

In the 1980's, commercial projects involving liquefied gas at pressures significantly above ambient are expected to be developed. This would include those concepts proposed for small North Sea and Southeast Asian offshore fields. Such concepts, which have significant merits, must be evaluated as total systems.

Also anticipated for the 1980's is more extensive utilization of the refrigeration at LNG import terminals. Such cold utilization would have a favorable effect on overall project economics.

The LNG industry has reached early adulthood. Although its growth has not achieved projected levels originally, LNG remains a most viable industry. Future growth, at least for this decade, is expected to continue at a measured pace. In the late 1980's and early 1990's, when conventional supplies decline, perhaps there will be a period of more rapid project development. Certainly in this intervening period the LNG industry will have established the base necessary to support whatever level of future growth occurs.

P&GJ

Profit Margins Are In Average Range

INCREASE IN PROFIT MARGIN from 4.8¢ to 5.9¢ on each dollar in sales is reported by 88 oil/natural gas companies for the year ending December 1979 compared to 1978. *Forbes* said "average returns for all U.S. industry for most recently reported 12-month period were 5.3¢ on sales." So oil companies' profit margins are in the "average" range as compared with all industries.

Higher prices and sales volumes of oil and natural gas accounted for earnings increases for Holly, Summit Energy, Texas Oil & Gas, Maynard, Diamond Shamrock, Callon Petroleum, Noble's Samedan, Sun, Triton Oil & Gas, Sohio and others.

Texaco said its U.S. earnings increase was due to improved refining/marketing activities compared with substantial losses in 1978. U.S. exploration/production results were up "due to higher prices for crude and natural gas as permitted by government price controls." Petrochemical earnings gained 77% over 1978 earnings.

Other international companies citing domestic earnings increases due to higher controlled prices of oil/gas are: Union California, Sun, Mobil, Pennzoil, Exxon, Atlantic Richfield, Cities Service.

Tenneco said gains in oil operations, with gains in six other major operating divisions accounted for Tenneco's record performance in 1979. Tenneco had 99% replacement of production by new reserves in 1978 and more than 100% in 1979.

Standard Indiana said overseas petroleum and worldwide chemical operations accounted for essentially all of the earnings gains in 1979. Overseas petroleum earnings were up 101% in 1979 over 1978; domestic petroleum earnings were down 8.7%.

For Conoco foreign operations gained 154%; U.S. petroleum operations rose 41%. Marathon's foreign earnings were up 95%; U.S. net was up 16%; U.S. refining/marketing operations declined in 1979...Mobil's foreign energy earnings were up 132%; foreign earnings accounted for 81% of the worldwide energy earnings increase. U.S. energy earnings increased 39%, due to higher crude/natural gas prices.

Standard California said earnings gains were due to improved product prices worldwide, increased oil/gas production. Petroleum earnings in U.S. were up 38%; foreign petroleum earnings were up 78%.

FOURTH QUARTER GAS COMPANIES FINANCIAL REPORTS

Company	Three months ending December 31**			Earnings* (\$000)			Twelve months ending December 31**			Earnings* (\$000)		
	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.
Alabama Tennessee N.G.	19,858	7,991	+148.3	1,073	526	+104.0	69,878	37,446	+86.6	4,893	3,172	+54.3
American Natural Res.	797,528	590,154	+35.1	60,969	21,844	+179.1	2,505,622	2,096,532	+19.5	117,956	127,419	-7.4
Arkansas Louisiana Gas	196,546	125,086	+57.1	8,738	9,482	-7.8	735,302	530,218	+38.7	60,741	53,286	+14.0
Columbia Gas	872,689	656,349	+33.0	42,451	31,615	+34.3	2,851,733	2,444,171	+16.7	143,113	121,096	+18.2
Commonwealth Nat. Res.	47,566	32,657	+45.7	1,374	752	+82.7	154,318	118,170	+30.6	5,504	3,777	+45.7
Consolidated Nat. Gas	640,760	445,711	+43.8	39,213	26,508	+47.9	2,045,947	1,585,906	+29.0	128,303	114,640	+11.9
El Paso Companies	905,959	581,390	+55.8	27,647	36,766	-24.8	3,088,556	2,030,636	+52.1	138,134	108,386	+27.4
Enserch Corp.	597,799	394,431	+51.6	21,200	6,700	+216.4	2,238,216	1,684,090	+32.9	84,500	56,300	+50.1
Houston Natural Gas ¹	561,371	352,584	+59.2	43,394	28,406	+52.8	2,006,622	1,536,003	+30.6	151,100	124,142	+21.7
Kansas-Nebraska N.G.	92,332	73,066	+26.4	7,154	3,635	+96.8	328,155	281,394	+16.6	19,653	18,578	+5.8
Mountain Fuel Supply							334,789	282,389	+18.6	23,875	20,061	+19.0
National Fuel Gas	188,751	151,504	+24.6	10,560	8,790	+20.1	653,957	556,397	+17.5	27,623	24,266	+13.8
Northern Natural Gas	775,687	538,757	+44.0	55,091	42,373	+30.0	2,449,202	1,981,988	+30.2	182,799	158,640	+31.9
Northwest Energy	384,879	263,320	+46.2	14,697	10,218	+43.8	1,119,532	819,982	+36.5	41,267	25,388	+78.4
Oklahoma Natural Gas	245,344 ²	185,326	+32.4	4,584 ²	5,415	-15.3	735,879	642,501	+14.5	31,244	38,761	-19.4
Pacific Lighting	705,085	475,281	+47.9	17,072	18,098	-5.7	2,244,279	1,749,395	+28.3	92,071	75,777	+24.8
Panhandle Eastern	549,707	411,010	+33.7	23,814	39,100	-39.1	1,967,657	1,410,957	+39.5	148,080	119,211	+24.2
Peoples Energy Corp.	752,690	572,963	+31.4	39,674	37,886	+4.7	2,621,284	2,015,913	+30.0	142,076	129,849	+9.4
Pioneer Corp.	200,248	128,028	+56.4	17,016	4,679	+63.6	732,486	556,012	+31.7	65,631	34,000	+93.0
Southern Nat. Res.	431,644	306,469	+40.8	25,917	25,284	+2.5	1,492,222	1,105,037	+35.0	109,415	103,422	+5.8
Texas Eastern Corp.	874,611	579,666	+50.9	50,357	35,130	+43.3	2,944,168	2,027,598	+45.2	180,551	137,206	+31.6
Texas Gas Transmission	498,404	343,986	+44.9	26,618	18,593	+43.2	1,686,560	1,214,411	+38.9	79,022	60,394	+30.8
TransCanada Pipelines							2,580,972	2,193,213	+17.7	87,168	87,926	-0.9
Transco Companies	468,944	283,869	+65.2	22,384	13,265	+68.7	1,528,108	953,748	+60.2	68,361	55,881	+22.3
Union Gas Ltd.	195,988	172,616	+13.5	3,525	6,075	-42.0	667,727	649,708	+4.2	16,978	22,295	-23.8
United Energy Res.	957,788	503,760	+90.1	28,380	16,953	+67.4	2,133,654	1,997,183	+7.1	111,687	82,393	+35.6
Westcoast Transmission							1,100,000	844,000	+30.3	49,900	44,900	+11.1
TOTALS	11,960,158	8,175,974	+46.3	592,902	448,093	+32.3	41,210,865	33,331,018	+23.6	2,311,645	1,927,166	+20.0

**Excluding non-recurring items. *Earnings available to common stock. ¹Ends October 31. ²Four months.

Exxon's refining/marketing component of U.S. earnings was down 62% from 1978 earnings...Marion's refinery was shut down for 5 days from hurricane damage, which adversely affected its third quarter results...Gulf also had fourth quarter "downstream" earnings decline because of "rapidly escalating foreign crude costs that were not passed on in the market place."

Diamond Shamrock's gains are attributed to new catalytic cracking capacity, increases in production of crude and natural gas and favorable natural gas liquids prices...Tomlinson acquired new production and had better earnings from increased oil/gas sales and refined product sales.

Quaker State said "improved earnings for 1979 were attributed primarily to a turnaround in coal operations." Other companies with increased coal earnings were Diamond Shamrock, Conoco and Mapco. Patrick Petroleum said its coal revenues were up 122%. R.L. Burns had 71% increase in coal sales.

Coal operations declined for Triton Oil & Gas. Gulf reported losses in its nuclear operations.

Pacific Lighting's earnings came almost entirely from non-utility operations; real estate made up the major part of its non-utility results.

Growing oil/gas exploration/production and profitable liquids extraction together provided 79% of operating income for Pioneer Corp.

Greater availability of natural gas was cited by Alabama Tennessee N.G., Transco Cos., and Commonwealth Natural Resources for increases in earnings.

Northern Natural Gas' liquid fuels and petrochemical groups contributed 52% to its earnings. Exploration/production division had its best year in 1979; natural gas earnings declined 12% from 1978 levels; coal operations have not yet contributed to Northern's earnings.

Houston Natural's oil/gas exploration/production division reported substantial increases in sales for the quarter ending Oct. 31. Exploration activities for the period resulted in the discovery of more natural gas than was produced.

Oil/gas exploration/production division of Texas Gas Transmission contributed \$196.1 million in revenues to the \$1.7 billion total.

FOURTH QUARTER OIL COMPANIES FINANCIAL REPORTS

Company	Three months ending December 31**					Twelve months ending December 31**					Profit Margin	
	Revenues (\$000)		Earnings* (\$000)		Chg.	Revenues (\$000)		Earnings* (\$000)		Chg.	1979	1978
	1979	1978	1979	1978		1979	1978	1979	1978			
1. Adams Res. & Energy	54,443	28,658	740	635	+16.5	178,893	103,634	4,439	3,046	+45.7	2.5	2.9
2. Altex Oil	213	158	48	(103)		679 ^b	957 ^b	(188) ^b	116 ^b	none	12.1	
3. Amarex ^c	3,905	2,674	786	(620)	+26.8	11,741 ^d	8,354 ^d	2,938 ^e	2,556 ^d	+14.9	25.0	30.6
4. Amco Energy	465	700	(155)	(241)		888 ^e	1,880 ^e	(247) ^e	(213) ^e	none	none	
5. Amerada Hess	2,123,725	1,214,809	118,897	38,181	+211.4	6,813,201	4,739,502	507,116	138,898	+265.1	7.4	2.9
6. Am. Petrofina	492,897	328,621	17,707	20,391	-13.2	1,622,575	1,173,799	83,187	32,351	+157.1	5.1	2.8
7. Arapaho Petr. ^f	2,907	3,514	169	106	+59.4	3,927 ^e	4,122 ^e	203 ^e	93 ^e	+118.3	5.2	2.3
8. Argonaut Energy	742	503	151	6	+2416.6	1,996 ^d	1,336 ^d	111 ^d	34 ^d	+226.4	5.6	2.5
9. Ashland Oil ^h	1,990,285	1,484,911	57,420	48,304	+18.9	7,245,737	5,601,458	185,359	159,400	+16.3	2.6	2.8
10. Asamera	72,605	41,900	1,907	1,356	+40.6	191,481 ^d	126,171 ^d	8,517 ^d	2,940 ^d	+189.7	4.4	2.3
11. Atlantic Rich.	5,049,617	3,270,071	342,958	222,574	+54.1	16,676,677	12,738,809	1,165,894	804,325	+45.0	7.0	6.3
12. Brock Expl.	1,631	830	428	221	+93.7	3,821 ^d	2,160 ^d	896 ^d	684 ^d	+31.0	23.5	31.7
13. R.L. Burns ^c	22,511	12,409	(2,535)	(2,543)		3,689 ^e	2,430 ^e	993 ^e	536 ^e	+85.3	26.9	22.1
14. Callon Petr. ^f	1,986	1,128	621	218	+184.9	7,731 ^e	5,063 ^e	6 ^e	(33) ^e	0.8	none	none
15. Centura Energy	5,648	3,690	184	140	+31.4	19,313 ^e	12,430 ^e	1,063 ^e	506 ^e	+100.0	10.2	11.0
16. Cities Service	1,804,200	1,229,400	106,200	(30,300)		6,276,700	4,660,900	347,500	118,000	+194.5	5.5	2.5
17. Clark O&R	332,017	265,947	16,070	8,954	+79.5	1,175,016	968,585	44,558	14,541	+206.4	3.8	1.5
18. Consolidated O&G	12,883	7,069	1,696	390	+334.9	37,035	26,105	2,151	45	+468.0	5.8	0.2
19. Conoco Inc.	3,795,700	2,829,700	190,700	155,200	+22.9	13,082,900	9,871,800	815,400	451,300	+80.7	6.2	4.6
20. Damsan Oil	6,558	3,911	585	226	+158.8	22,226	13,811	1,063	506	+100.0	10.2	11.0
21. Diamond Shamrock	666,129	475,398	58,507	46,178	+26.7	2,351,606	1,817,983	178,123	139,132	+28.0	7.6	7.7
22. Dorchester Gas ^f	143,647	69,454	8,750	4,059	+115.6	4,059	4,059	178,123	139,132	+28.0	7.6	7.7
23. Earth Resources ^f	132,794	92,840	6,699	3,276	+104.4	446,199	384,725	19,910	11,886	+67.5	4.4	3.1
24. Energy Minerals	2,503	1,816	878	610	+43.9	7,002 ^d	4,892 ^d	1,212 ^d	1,829 ^d	+16.5	30.4	37.3
25. Energy Sources ^c				1,953		1,953	2,981	(27)	(300)	none	none	
26. Exxon	24,074,000	17,308,000	1,365,000	853,000	+60.0	79,981,000	61,325,000	4,295,000	2,763,000	+55.4	5.4	4.5
27. Galaxy Oil ^f	2,151	1,786	62	131	-52.7	6,037 ^e	5,904 ^e	1,384 ^e	(312) ^e	22.9	none	
28. General American	57,117	37,190	15,492	9,162	+69.1	108,749 ^e	71,382 ^e	27,227 ^e	15,779 ^e	+72.6	25.0	22.1
29. Getty Oil	1,546,526	1,033,215	182,590	101,546	+79.8	5,120,739	3,758,148	604,434	330,087	+83.1	11.8	8.8
30. Great Basins ^c	6,010	6,199	(1,638)	547		19,313 ^e	12,430 ^e	1,063 ^e	506 ^e	+100.0	10.2	11.0
31. Gulf E&O	24,726	6,058	2,117	583	+263.1	54,589	20,227	5,552	2,222	+150.0	10.2	11.0
32. Gulf Oil Corp.	7,727,000	5,446,000	366,000	237,000	+54.4	26,137,000	20,094,000	1,322,000	785,000	+68.4	5.1	3.9
33. Helmerich & Payne	46,862	36,612	10,452	8,144	+28.3						21.2	19.2
34. Holly Petr. ^c	100,719	71,949	2,893	2,217	+30.7						2.9	3.1
35. Inexco Oil	29,348	16,092	5,372	2,193	+145.0	102,677	71,605	17,504	10,316	+69.7	17.1	14.4
36. Intercontinental	1,705	4,197	(405)	586		19,979 ^b	5,594 ^b	4,536 ^b	(2,528)	41.3	none	
37. Kerr-McGee Corp.	755,470	543,542	40,396	40,023	+0.9	2,683,469	2,072,443	160,017	118,196	+35.4	6.0	5.7
38. Lear Petr.	22,858	18,001	1,760	922	+90.9	83,172	61,725	5,845	3,560	+64.2	7.0	5.8
39. Louisiana L&E	246,352	144,601	44,313	22,949	+93.1	817,014	549,416	169,044	94,778	+78.4	20.7	17.3
40. Mapco	305,558	169,178	24,251	21,971	+10.4	857,912	571,815	72,113	60,784	+18.6	8.4	10.6
41. Marathon	2,220,287	1,372,160	54,261	73,867	-26.5	7,199,522	4,954,710	323,225	225,169	+43.5	4.5	4.5
42. Marion ^f	75,143	50,350	5,660	1,811	+212.5	224,533	134,775	14,380	5,431	+164.8	6.4	4.0
43. Maynard ^f	5,935	3,742	820	281	+191.8	10,231 ^e	7,879 ^e	1,141 ^e	615 ^e	+85.5	11.2	7.8
44. McMoran O&G	10,062	4,957	874	13	+6623.1	17,643	9,723	1,750	550	+218.2	9.9	5.7
45. Mesa Petroleum	87,499	45,654	16,361	11,524	+42.0	269,420	166,517	54,203	41,766	+29.8	20.1	25.1
46. Mitchell Energy ^h	116,974	69,478	11,885	7,605	+56.3	304,393 ^d	196,781 ^d	31,907 ^d	25,078 ^d	+27.2	10.5	12.7
47. Mobil Corp.	14,490,000	10,681,000	541,000	315,000	+71.7	47,941,000	37,331,000	2,010,000	1,311,000	+77.7	4.2	3.0
48. Murphy Oil	411,363	303,498	38,007	17,382	+118.7	1,590,384	1,217,689	103,567	64,589	+122.3	6.5	3.8
49. Natamos	283,403	230,579	34,182	13,112	+260.7	1,010,208	882,674	110,788	62,334	+77.7	11.0	7.1
50. Noble Affiliates	61,942	47,206	10,913	5,500	+98.4	213,838	176,221	33,041	24,710	+33.7	15.5	14.0
51. Ocean O&G	18,792	10,358	3,539	574	+516.6	58,354	32,741	9,363	2,593	+261.1	16.0	7.9
52. Pacific Resources	172,315	133,155	3,805	2,845	+33.7	554,068	471,679	13,722	9,268	+48.1	2.5	2.0
53. Patrick Petr. ^c	8,807	10,566	(740)	1,063	-169.6	37,863	28,197	(108)	2,065	-105.2	none	7.3
54. Patton Oil	857	209	221	(245)		1,928 ^d	663 ^d	457 ^d	(280)	23.7	none	
55. Pauley Petr. ^f	42,850	24,216	3,145	140	+2146.4						7.5	0.6
56. Pennzoil Co.	603,064	447,706	72,008	41,881	+71.9	2,051,693	1,553,108	233,789	123,170	+89.8	11.4	7.9
57. Petro-Lewis	25,271	11,556	4,155	1,070	+288.3						16.4	9.3
58. Phillips Petr.	3,044,789	2,200,002	306,491	279,539	+9.6	9,744,750	7,421,942	891,121	718,117	+24.1	9.1	9.7
59. Premier Res.	1,262	924	398	15	+2553.3	4,364 ^b	4,085 ^b	195 ^b	719 ^b	+72.7	4.5	17.5
60. Presidio Oil Co.	1,042	506	54	19	+184.2	3,385	2,277	86	143	+39.9	2.5	6.3
61. Quaker State	178,494	130,431	5,064	6,774	-25.2	691,641	513,188	34,121	25,345	+34.6	4.9	4.9
62. Sabine Corp.	25,684	19,309	5,258	1,308	+302.0	84,295	54,631	14,561	7,183	+102.7	17.3	13.1
63. Seneca Oil ^h	897	511	33	38	-13.2	2,587	1,608	70	184	-62.0	2.7	11.4
64. Shell Oil	4,301,300	2,923,600	331,200	192,300	+72.2	14,546,200	11,123,000	1,125,600	813,600	+38.3	7.7	7.3
65. Southland Royalty	76,230	45,372	16,962	10,013	+69.4	256,611	183,553	54,752	42,540	+28.7	21.3	23.2
66. Standard Cal.	9,806,000	6,835,000	524,000	316,000	+65.8	31,775,000	24,597,000	1,785,000	1,089,000	+63.9	5.6	4.4
67. Standard Indiana	6,069,900	4,298,700	368,700	216,700	+70.1	20,215,300	16,349,800	1,506,600	1,076,400	+40.0	7.5	6.6
68. Standard Ohio	2,349,700	1,540,400	451,000	164,500	+174.2	7,916,000	5,197,700	1,186,100	450,200	+163.5	15.0	8.7
69. Statex Petr. ^c				4,224		4,067 ^d	3,912 ^d	787	695	+13.2	18.6	17.5
70. Summit Energy ^c	1,257	1,182	530	642	-17.4						12.1	41.9
71. Sun Co.	3,200,000	2,100,000	222,900	107,600	+107.2	10,800,000	7,600,000	699,900	414,700	+68.8	6.5	5.5
72. Superior Oil	306,566	215,911	47,682	17,162	+177.8	1,085,394	730,942	200,287	87,511	+128.9	18.5	12.0
73. Supron Energy	14,053	9,540	4,796	2,658	+80.4	48,142	35,560	14,454	10,003	+44.5	30.0	28.1
74. Tenneco	3,306,000	2,484,000	157,000	123,000	+27.6	11,337,000	8,877,000	539,000	421,000	+28.0	4.8	4.7
75. Tesoro ^b	1,032,191	323,139	34,359	10,672	+222.0	3,107,500	1,315,000	72,100	31,100	+131.8	2.3	2.4
76. Texaco Inc.	12,013,000	8,264,000	533,929	328,261	+62.7	39,096,000	29,124,000	1,759,069	852,461	+106.4	4.5	2.9
77. Texas O&G	267,740	167,105	29,259	19,270	+51.8	899,497 ^d	712,293 ^d	97,277 ^d	76,534 ^d	+27.1	10.8	10.7
78. Tipperary Corp.	19,348	11,130	2,066	359	+475.5	66,685	47,086	2,997	(3,661)	4.5	none	
79. Tomlinson ^f	13,697	6,441	1,522	313	+386.3						11.1	4.9
80. Tosco Corp.	549,185	318,025	24,556	6,011	+308.5	1,922,237	1,165,697	78,028	18,033	+332.7	6.7	1.6
81. Total Petr. N.A.	279,463	175,495	11,426	6,505	+75.6	910,505	572,310	29,871	14,416	+107.2	3.3	2.5
82. Triton O&G ^f	4,195	4,000	566	66	+757.6	7,363	7,638	639	246	+159.8	8.7	3.2
83. Union Calif.	2,213,400	1,676,200	152,300	123,800	+23.0	7,679,100	6,105,100	500,600	382,300	+30.9	6.6	

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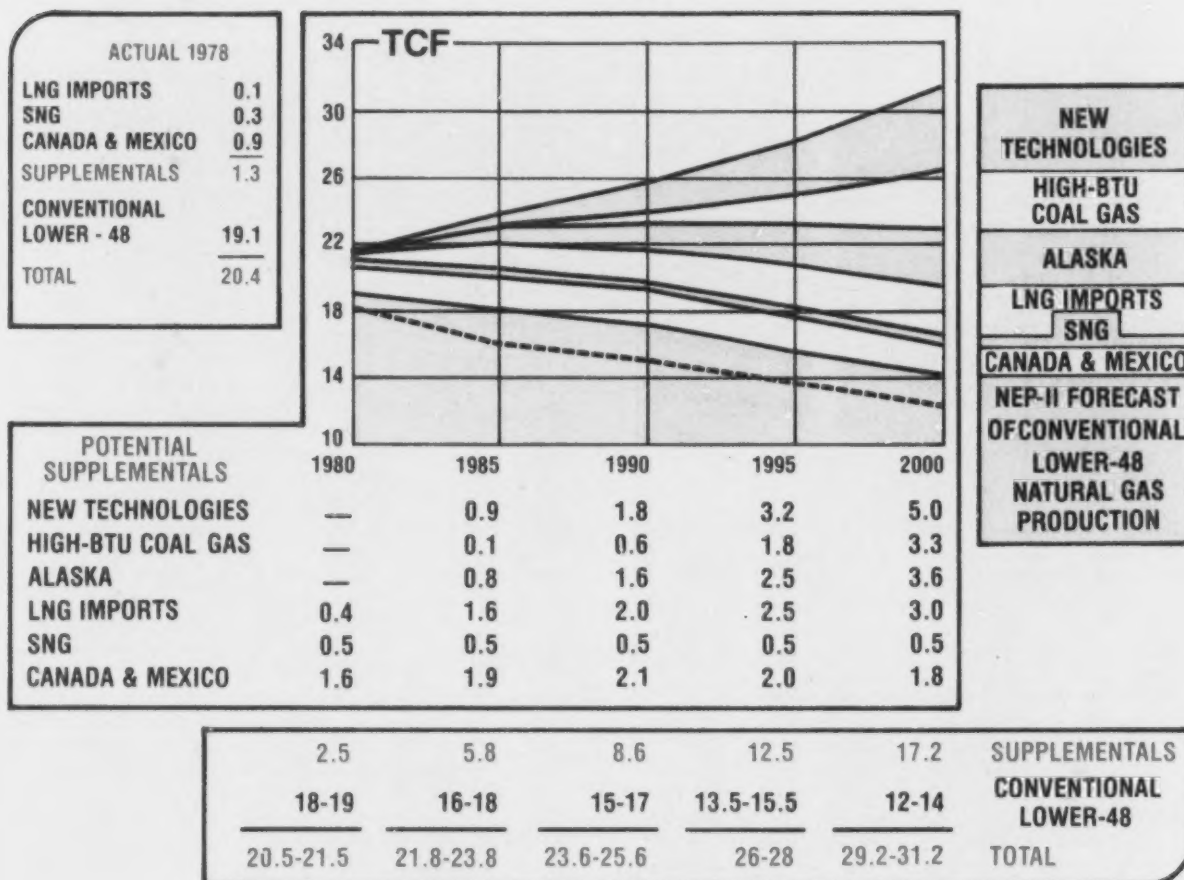
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THE COVER

Primary concern is given customer service by Wisconsin Power & Light Co. when gas distribution system upgrading projects are undertaken; crews begin lawn, sidewalk, and street restoration immediately after completing underground work.

— Courtesy Wisconsin Power & Light Company





Summary of potential gas supplies through the year 2000.

Future Gas Supply, Demand, Construction Solid

by George H. Lawrence, President, American Gas Association, Arlington, Virginia

America's gas industry is moving into the 1980s on a solid and optimistic footing. Terms such as *renaissance*, *revival*, *resurgence*, and *optimism* are commonly used among those inside the industry to describe the current prospects for gas energy, both now and in the future.

These positive words come from a variety of respected sources, many of them in the financial community, whose support will be vital to the gas industry's future. Merrill Lynch, Salomon Brothers, First Boston, and Morgan Stanley all have issued optimistic reports strongly supporting the gas energy option. Recent additions to the list include Argus Research Corporation and Lehman Brothers Kuhn Loeb Research.

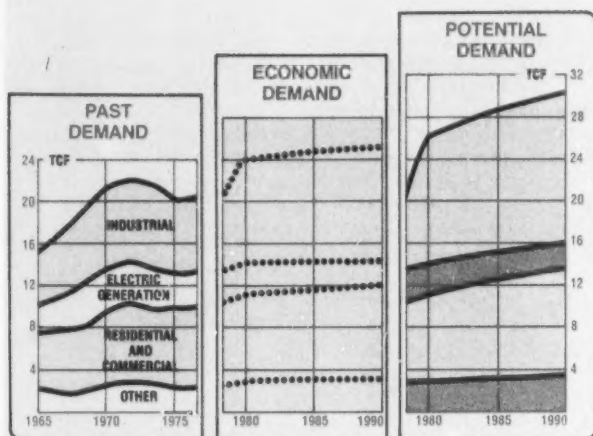
A February 13 *Wall Street Journal* article quoted Foster Corwith of Argus as saying "Natural gas appears to be well positioned to supply a significant portion of the country's

long-term incremental energy needs." The article detailed the "Bright Outlook" for gas stocks.

In a January 8 "Industry Review" report, Edward I. Lefferman of Lehman Brothers concluded that "In sum, the developments in recent months reinforce our conviction that the industries involved in natural gas face a bright fundamental outlook."

An August, 1979 report by Morgan Stanley and Co. was equally positive. Under the title "Natural Gas: Renaissance of an Industry," the company's analysts cited a number of reasons for the gas industry's resurgence:

- Passage of the Natural Gas Policy Act (NGPA) in November, 1978, which eliminated economic barriers to greater gas sales by allowing intrastate gas to move into the interstate market.
- A significant increase in the search for new gas reserves by independent and major exploration companies;



Potential gas demand through 1990. Economic demand (middle chart) is based on price and technology alone, not constrained by regulations, misperceptions of short supply, and other restraints. Potential demand reflects continuing environmental restrictions on coal use and federal policy discouraging oil imports.

- Economic attraction of gas as compared to higher-priced fuels;
- Reversal in government policies which had discouraged the use of natural gas; and
- Reinforcement of the environmental advantages of gas.

The report points out the importance of, and opportunities for, the gas industry to increase supplies in order to meet future demand: "The possibility of increased gas demand exists in every market. Until only recently, however, producers' and distributors' desires to serve that demand were stymied by an environment that discouraged additional production and expanding markets. Promoting that incremental supply is imperative if the industry is to keep pace with demand. Maintaining current production levels will provide a challenge to the industry."

Major Expenditures Planned

This is a challenge the gas industry is meeting in many different ways.

Among these are major expenditures for utility maintenance and construction, equipment maintenance and acquisition, and pipeline maintenance and construction. The gas industry will spend a total of more than \$300 billion (1978 dollars) between 1979 and 2000 for utility and pipeline construction.

Forecasts for construction budgets indicate that annual expenditures will be in the \$5 billion dollar range for the next two to three years. This compares to budgets of only about \$2 billion during the recent 1975-1977 period.

The nation's gas delivery system — transmission pipelines and distribution mains — is itself an invaluable national resource. It is the most extensive and most dependable energy delivery system in the nation, covering over a million miles. From present underground gas storage facilities connected to the system the industry can deliver the gas equivalent of a billion barrels of crude oil.

Over \$2 billion annually is forecast for 1981 and again in 1982 for distribution construction alone. Of the nearly 9,000 miles of pipeline built in the U.S. last year, about 60% was for natural gas projects. Much of this consisted of projects involving pipe larger than 20-in.

On the conventional supply front, gas well completions last year scored an impressive 13% overall gain over 1978, possibly reaching the highest level in history. Seismic activity also reached a twenty year high level, a positive indica-

tor for future drilling activities. Deregulation of wellhead prices for "deep gas" (below 15,000 ft) has resulted in a 10% increase in well completions in the areas of deep drilling, a category that the Potential Gas Committee thinks may hold 20% of all potential gas supplies.

Offshore exploration is another area of high potential and offshore gas well completions increased by 10% in 1979. An increase of approximately 34% occurred in oil and gas drilling on the Western Overthrust Belt, while price deregulation of Devonian Shale Gas contributed to a 20% increase for gas well completions in the Appalachian Basin.

There are between 35 and 60 years of recoverable conventional gas supplies remaining to be produced in the U.S. at our present rate of consumption. In addition, the resources contained in other, unconventional gas formations — geopressurized methane, gas from Devonian Shale and tight sands, methane from coal seams — far exceed conventional sources, and are practically unlimited.

To meet the growing demand for gas energy, a substantial contribution will come from supplemental sources. A number of agreements and regulatory decisions in recent months have greatly improved the outlook for gas energy from these sources.

Final approval has been granted for construction of an LNG facility at Point Conception, Calif. which will receive and regasify Alaskan and Indonesian LNG. The U.S. could be importing two trillion cubic feet (Tcf) of LNG per year by the end of this decade and as much as three Tcf by 2000. Significant environmental, employment, price and balance of payments advantages exist for LNG over imported oil.

About The Author

George H. (Bud) Lawrence, president of the American Gas Association, is a petroleum engineer and attorney in the natural gas and petroleum industries with 30 years' experience.



Lawrence has been with A.G.A., the national industry association for natural gas distribution and transmission companies, since July 1968. He joined A.G.A. as manager of the Washington office when the association headquarters was in New York City, served successively in a number of key positions after A.G.A. moved to Arlington, Va., in 1970, and assumed the presidency of A.G.A. on November 1, 1976.

From 1949 to late 1959, he was petroleum engineer in the Production Department of Humble Oil and Refining Company, Houston, Texas (now EXXON U.S.A.), and then as an attorney for Humble specializing in natural gas and Federal Power Commission matters until early 1962, when he moved to Humble's Natural Gas Division at the assistant manager level. In May 1963, he entered the private practice of law and was a petroleum engineering consultant in Houston. From late 1964 to July 1968, he was with the American Petroleum Institute in Washington, D.C. as Natural Gas Coordinator.

Lawrence, a native of Bartlesville, Oklahoma, received a B.S. degree in Industrial Engineering in 1949 from Oklahoma State University and an L.L.B. degree from South Texas College of Law, Houston, in 1957.

He is a registered professional engineer in the State of Texas, and a member of the American Bar Association; Texas Bar, and Federal Energy Bar Association. He serves on several boards of directors including the National Energy Foundation, the Council for Urban Environmental Studies, and the Ford's Theater Society.

Lawrence most recently was accorded honors by the National Energy Resources Organization (NERO), which awarded him a 1980 Energy Merit Award for distinguished service in contributing to the nation's energy problems in 1979.

Last year's agreement to import Mexican gas, coupled with a greater flow of Canadian gas, was a positive step in the supplemental area. Financing arrangements for the Alaskan natural gas pipeline are also progressing. Alaska has 31.6 Tcf of proven reserves that, when added to the Potential Gas Committee's resource estimates, totals over 200 Tcf, or 10 times the amount of gas the U.S. consumes annually. By the mid 1980s, residents of the West Coast and Midwest could be using Alaskan gas.

The gas industry is on the brink of a whole new chapter in the gas supply story. This first step in producing vast new quantities of gas from America's enormous reserves of coal has been taken. The Federal Energy Regulatory Commission (FERC) has approved plans for building the nation's first commercial-sized coal gasification plant in Mercer County, N. Dak. The Great Plains Coal Gasification project is intended to demonstrate the economic feasibility of building these plants and to show the major contribution a coal gas industry can make toward meeting future energy needs.

Many new and promising future technologies for producing gas energy constitute another source of confidence in the gas industry's future. Among these are gas from land and marine biomass, gas from organic and municipal wastes, peat gasification, gas hydrates, and hydrogen. These and other technologies, perhaps as yet undiscovered, underscore the possibility that the future for gas energy may in fact be virtually limitless. Research and development have had and will continue to have a very high priority in this country's gas industry.

A positive future for gas supply obviously is good news for an industry expecting a 25% increase in demand to about 25 to 28 Tcf per year by 1990 — less than 10 years from now. This demand for gas in traditional markets — residential, industrial, commercial — will be even greater

if there are increased government restrictions on importing oil and if strict environmental laws are maintained or stiffened. Additional demands could come from nontraditional markets such as automotive fleet fueling, gas cooling and air conditioning, and gas burned alternately with coal at problem pollution times.

Demand also will be accelerated by customer growth. The staggering increases in the cost of imported oil refined into home heating oil has caused a sharp increase in demand for residential oil-to-gas conversions. Many gas utilities are receiving more than 1000 requests per month for space heating service.

Customer growth for 1980 is expected to exceed the highest growth experienced in the last 30 years. The American Gas Association estimates that 225,000 homeowners converted from oil to gas in 1979, a 57% increase over 1978. And 550,000 new homes installed gas heat.

With A.G.A. projections indicating gas will retain its price advantage over oil and electricity for house heating until 1990 and beyond, the residential market demand is unlikely to diminish.

The U.S. Department of Energy's announced policy of doing everything possible to reduce oil imports includes encouraging some industries to switch from oil to gas, further stimulating demand for gas. Last year natural gas displaced oil at a rate of 435,000 bbl per day in industrial energy markets for an estimated savings of \$4 billion in foreign oil payments.

A continuing supply of gas energy for the pipeline today and far into the future is the gas industry's goal. The demands for gas energy and its delivery system are expected to grow rather than shrink. Fortunately, the 1980 prognosis for meeting this demand is excellent. The "Gas Option" will play an important role in America's energy picture. **P&GJ**

Nearly 350,000 Miles of Pipe, Over \$70-Billion Expenditures Projected For 1980's

Growth pattern of the U.S. gas industry in terms of piping installed and expenditures for construction of that piping has been projected by PIPELINE & GAS JOURNAL's market research group for the 10-year period of 1980 through 1989.

As shown in the table below, the gas industry in aggregate will install 349,792 miles of new pipe — as cross-country transmission pipelines, field and gathering lines, gas mains, and gas services — during the 10-year period.

Expenditures for the decade will total a projected \$70.154 billion, of which \$10.8 billion has been allocated to the Alaskan and Lower 48 States portions of the Alaska Highway

Gas Pipeline Project during the 1981 through 1989 period. (Cost increases for this project beyond the \$10.8 billion figure have not been included.) The projection assumes that the project will officially get underway sometime in late 1980 or early 1981.

Gas distribution growth figures are predicated on continuing expansion in the number of residential, commercial, and industrial customers, plus replacement of outdated facilities to meet new customer demands and to meet system standards dictated by federal and state regulatory agencies.

U.S. GAS INDUSTRY PIPING FORECAST — 1980-1989

Projection	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Miles of Gas Pipeline	4,246	4,350	4,500	4,800	4,250	4,000	4,200	4,100	4,300	4,050
Miles of Gas Gathering & Field Lines Installed	1,200	1,350	1,400	1,400	1,300	1,300	1,300	1,250	1,200	1,350
Total Miles of Gas Pipelines Installed	5,446	5,700	5,900	6,200	5,550	5,300	5,500	5,350	5,500	5,400
Miles of Gas Mains Installed	13,448	14,000	14,900	14,800	14,400	14,600	14,200	14,200	14,700	15,100
Miles of Gas Services Installed	13,798	14,000	14,200	14,600	14,700	15,000	15,600	15,500	15,900	15,900
Total Miles, All Gas Industry Piping Installed	32,692	33,700	35,000	35,600	34,650	34,900	35,700	35,050	36,100	36,400
Construction Expenditures, \$Billion, Pipeline	1.381	4.318	4.825	5.317	4.143	3.073	2.930	3.135	3.546	3.829
Construction Expenditures, \$Billion, Distribution	1.781	2.049	2.381	2.646	2.987	3.402	3.870	4.299	4.872	5.370
Total Construction Expenditures, \$Billion	3.162	6.367	7.206	7.963	7.130	6.475	6.800	7.434	8.418	9.199

Source: Pipeline & Gas Journal



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THE COVER



Pipeline manifolds are a familiar sight at any crude oil pipeline terminal. This one belongs to Williams Pipeline Company, one of America's largest operators.

—Courtesy Williams
Pipe Line Co.

Liquids Pipeline Forecast



Over 11,000 Miles Oil Pipeline Planned For U.S., Canada

by Dean Hale, Editor

Spurred by four major products pipeline projects with 1980 construction, plus another products line project to be built in 1981, the liquids pipeline business appears on its way to another premier year.

By mid-May there were a total 11,086 miles of underway, planned, and proposed crude oil pipelines and refined products/LPG/natural gas liquids pipelines on the books for the U.S.

and Canada. A number of the major projects and most of the smaller ones are underway.

Of the total, there are 8560 miles of underway, planned, or proposed lines in the U.S., of which 3533 miles involve crude lines and 5459 are products lines. In Canada, the Construction projects include 1926 miles of crude oil pipelines and 600 miles of products lines.

Products Lines

MAPCO Inc., in mid-April, announced that it will build a new Rocky Mountain LPG pipeline and gathering system to connect newly-discovered fields of the southwest Wyoming and northeast Utah Overthrust Belt to its existing system at Kutz, N. Mex. That extension includes 328 miles of 4-, 6-, 8-, and 10-in. gathering lines plus a 454-mile 10- and

Underway, Planned & Proposed Oil Pipeline Projects

U.S.—Crude Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS	CONTRACTOR OR ENGINEERING CO.
Amoco Pipeline Co.	50	N. A.	Tree Top, N. Dak.	Dunn Center, N. Dak.	Planned	
ARCO Pipeline Co.	31.5	36	Texas City, Tex.	Pasadena, Tex.	Comp. 7/15	Reading & Bates
Ashland Pipeline Co.	100	6-16	Prudhoe Bay		Start 9/80	Williams Bros. Eng. Co.
Ashland Pipeline Co. (w/DOE)	14	20	Cattlettsburg, Ky.	Ironton, Ill.	Proposed	
Department of Energy	42	24	Kleer Mine Storage, Tex.	Texoma, Tex.	Approved	
	25	36	W. Hackberry Dome, La.	Block 42, W. Cameron Area	Await Start	
	13	20	S. Ohio Strategic Storage Reserve		Proposed	
Exxon U.S.A.	8	6, 10, 16	Corpus Christi Area		Planned	
Gulf Oil Corp.	61	8, 16	Iberia, Vermilion & Cameron areas, offshore La.		Before USCE	
	37	6, 12, 16	Grand Is. & S. Timbalier areas, offshore La.		Planned	
	27	12, 20	Terrebonne & Lafourche parishes, La.		Before USCE	
Koch Exploration Co.	16	6	St. Bernard & Orleans parishes, La.		Before USCE	
Locap Pipeline (Shell et al.)	53	48	Clovelly Dome, La.	St. James Terminal, La.	Underway	H. C. Price
New England Energy Co.	35	24	Portland, Me.	Sanford, Me.	Before EPA	
Northern Pipeline Co. (Delaware)	475	24	Wood River, Ill.	Pine Bend, Minn.	Planned	
Northern Tier Pipeline Co.	1557	40, 42	Port Angeles, Wash.	Clearbrook, Minn.	Engineering	Butler; Williams Bros.
Northville Industries	174	30	Texas City, Tex.	Houston-Freeport-Nederland	Planned	
Phillips Pipeline Co.	20	10	San Bernard, Tex.		Planned	
Provident Energy Co.	204	16	Kingman, Ariz.	Mobil, Ariz.	Planned	
Santa Fe Energy Co.	24	24	Trinity Co., Tex.	Refinery (Proposed)	Engineering	
Shell Oil Co.	41	6, 8	Vermilion & Marsh Is. areas, offshore La.		Before USCE	
	28	12	Block 128, Mississippi Canyon, offshore La.		Planned	
	20	12	W. Delta & Grand Is. areas, offshore La.		Before USCE	
	9	8	Block 311, Mississippi Canyon, offshore La.		Planned	
Sioux Pipeline Co.	160	10	Superior, Wisc.	St. Paul, Minn.		
Southern Union Refining Co.	47	8	Midland, Tex.	Lovington, N. M.	Engineering	International Pipeline Engineers
Texaco Inc.	21	6, 8	Port Arthur, Tex.		Planned	
Texas Deepwater Port Authority	26 (Dual)	52	Offshore Freeport, Tex.	Shore		
Wallace & Wallace Chemical & Oil Co.	214	22-30	Mobile, Ala.	Tuskegee, Ala.	Planned	Ford, Bacon & Davis

U.S.—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS	CONTRACTOR OR ENGINEERING CO.
Barbour Energy Co., Inc.	390	20	Brownsville, Tex.	Houston	Under Study	Ford, Bacon & Davis
Battery Limits Project	525	16	Western N. D.	Duluth	Under Study	Wentworth Assoc.
Cal-Nev Pipeline Co.	54	6	Edwards AFB, Calif.	George AFB, Calif.	Planned	
Colonial Pipeline Co.	141	36	Mitchell Junction, Va.	Dorsey Junction, Md.	Underway	Cap-Con; Worthy Bros.
Chase Transportation Co.	131	8, 12	Loops on El Dorado, Kan.	Denver, Colo. System	Underway	
	32	8, 12	Dorsey Junction, Md.	So. Baltimore	Planned	
Dorchester Gas Producing Co.	25	6	Sterling Co., Tex.		Underway	
Enterprise Products Co.	55	6	Jay, Fla.	Alabama	Underway	
	23.5	16	Houston Ship Channel	Mont Belvieu, Tex.	Comp. 5/15	W. L. Golightly
Exxon Pipeline Co.	66	8				
	28	4-8	Baytown, Tex.		Await Start	H&K Construction Co.
Getty Pipeline Co.	25	16	Delaware City, Del.	Marcus Hook, Pa.	Underway	Worthy Bros.
Hydrocarbon Transportation, Inc.	240	10	Bushton, Kans.	Plattsburg, Mo.	Comp. 6/15	Williams Bros.; Great Plains
LOOP Inc.	21	4	Fourchon Station, La.	Offshore Platform	Comp. 5/80	Santa Fe
Mapco Inc.	1197	4-6-8-10	N. M., Wyo., Colo. & Utah		Planned	
Phillips Pipeline Co.	421	16	Borger, Tex.	Paola, Kans.	Start 8/1	
Transgulf Pipeline Co.	800	24	Baton Rouge, La.	Ft. Lauderdale, Fla.	Planned gas-products conversion	
Southern Pacific Pipeline Inc.	36	24	Norwalk, Calif.	Colton, Calif.	Planned	
Union Carbide Corp.	13	6	Napoleonville, La., area		Planned	
Williams Pipeline Co.	691	24	Cushing, Okla.	Mason City, Iowa	Under Study	
	112	24	Des Moines, Iowa	Mason City, Iowa	Under Study	

CANADA—Crude Oil Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS
Dome Petroleum	284	6-12	Peace River, Alta	Niton Junction, Alta	Proposed
Esso Resources Canada Ltd. (Interprovincial Pipeline Ltd.)	560	12	Norman Wells, N.T.	Zama, Alta	Planned
Federated Pipelines Ltd.	284	4-12	Hythe, Alta	Swan Hills, Alta	Proposed
Husky Oil Co.	600	2-12	Alta-Sask. gathering		Planned
Interprovincial Pipeline Ltd.	28	34	Camrose Area, Alta		Before NEB
Murphy Oil Co., Ltd.	28	10	Onity, Sask. area		Planned
Peace Pipeline Ltd.	142	12	Cutbank Lake, Alta	Fox Creek, Alta	Proposed

CANADA—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS
Amoco Canada Petroleum Co., Ltd.	500	12	Sarnia, Ont.	Quebec City, Que.	Planned
Pan Canadian Petroleum Co., Ltd.	100	10	LPG line		Planned

12-in. line between Rock Springs, Wyo. and Kutz. Additionally, MAPCO will build a 415-mile, 10- and 12-in. loop of its line between Kutz and Hobbs, N. Mex.

Liquids received in the new line will ultimately move to MAPCO's Conway, Kan. plant for fractionation and further movement to markets in the upper Middle West. Connections will be made in West Texas to other pipelines for movement to the Gulf Coast.

Cost of the MAPCO project is estimated at \$110 million. The total project — pipeline and related stations (35,000 hp to be added at new and existing stations) — is expected to take three years to complete. Mainline should be complete by end of 1980 with a capacity of 20,000 bbl per day. In 1981 capacity will be expanded to 65,000 bbl per day.

Phillips Pipe Line Co. will install a new 421-mile, 16-in. products pipeline between Borger, Tex. and Paola, Kan. this year that will replace an existing 8-in. line and enable it to close eight of 13 pump stations on the Borger-Paola segment of the Phillips pipeline system.

The 8-in. line to be replaced was laid in the early 1930's and was the first long-distance pipeline to transport several kinds of liquid petroleum products. A parallel 12-in. line installed later will remain in service. Present capacity of the 8- and 12-in. lines is 140,000 bbl per day. When the new line is completed, the 12- and 16-in. system will move the same volume but will have 21,000 less horsepower.

Santa Fe Pipeline Co. has also announced plans for approximately 800 miles of new pipeline — to be 8-, 10-, or 12-in. in size — from a Texas location a few miles east of Hobbs, N. Mex. to either the Mont Belvieu or Bay City, Tex. area.

The line will connect with MAPCO's new line from the Rocky Mountain Overthrust Belt area. It will also transport additional volume from new

and expanded natural gas liquids production facilities in West Texas and the Austin Chalk areas. Cost of the pipeline, which will essentially parallel SFPL's Chaparral Pipeline System, is estimated at \$70 to \$75 million.

Colonial Pipeline Co. has let contracts and work is underway on the 1980 portion of the company's parallel line expansion. Approximately 141 miles of 36-in. will be laid this year between Richmond, Va. and the Baltimore, Md. area.

Work is underway on 240 miles of 10-in. line between Bushton, Kan. and Plattsburg, Mo. for Hydrocarbon Transportation, Inc. The line will transport natural gas liquids.

Chase Transportation Co. is completing 131 miles of 8- and 12-in. loops on its El Dorado, Kan. to Denver, Colo. products pipeline system.

Williams Pipe Line Co. is studying plans for approximately 700 miles of 24-in. line that would link Cushing, Okla. to Mason City, Iowa and Des Moines, Iowa.

Barbour Energy, Inc. has proposed a 390-mile, 20-in. products line between a proposed new refinery at Brownsville, to the Houston-Baytown area.

Exxon is reported to have plans to build 94 miles of 4 through 8-in. products lines in 1980, including 66 miles of 8-in. ethylene line from Baytown to Groves, Tex.

Cal-Nev Pipeline plans to install 54 miles of 6-in. this year between Edwards Air Force Base and George Air Force Base in Kern County, Calif.

Crude Oil Lines

Northern Tier Pipeline, survivor so far in the battle to move Alaskan North Slope crude oil from the West Coast to midwestern U.S. markets, is currently busy arranging financing and acquiring the remainder of its permits so it can build the 1557-mile, 40- and 42-in. pipeline from Port Angeles, Wash. to Clearbrook, Minn. En-

gineering design is underway (Butler Associates, Williams Brothers Engineering, Co.) along with numerous other associated activities. If everything falls into place for Northern Tier by the end of 1980, work may get underway in 1981.

Locap Pipeline, the 57-mile, 48-in. line connecting Clovelly Dome of the LOOP Pipeline to St. James Terminal, is under construction and expected to be completed in mid-1980.

ARCO Pipeline has underway 32 miles of 36-in. between Texas City and Pasadena, Tex.

On the west coast, at Long Beach Harbor, **Shell Oil Co.** is installing a 16-mile, 16-in. line.

Northern Pipe Line Co. (Delaware) continues to be stymied in its efforts to build a 475-mile, 24-in. pipeline between Wood River, Ill. and Pine Bend, Minn., near the Twin Cities. Biggest obstacle is the State of Iowa, which has expressed a distaste for pipelines of any type. Further court action is expected to help advance this job.

Provident Energy Co. has proposed a 204-mile, 16-in. line in Arizona, between Kingman and a new refinery at Mobil, Ariz.

Sioux Pipeline Co. is studying a proposal to build a 160-mile, 10-in. crude line linking Superior, Wis. and the St. Paul, Minn. area.

Department of Energy has four projects on its boards, involving 94 miles of pipeline, ranging from 20-in. to 36-in., that would serve major storage areas of the Strategic Petroleum Reserve program.

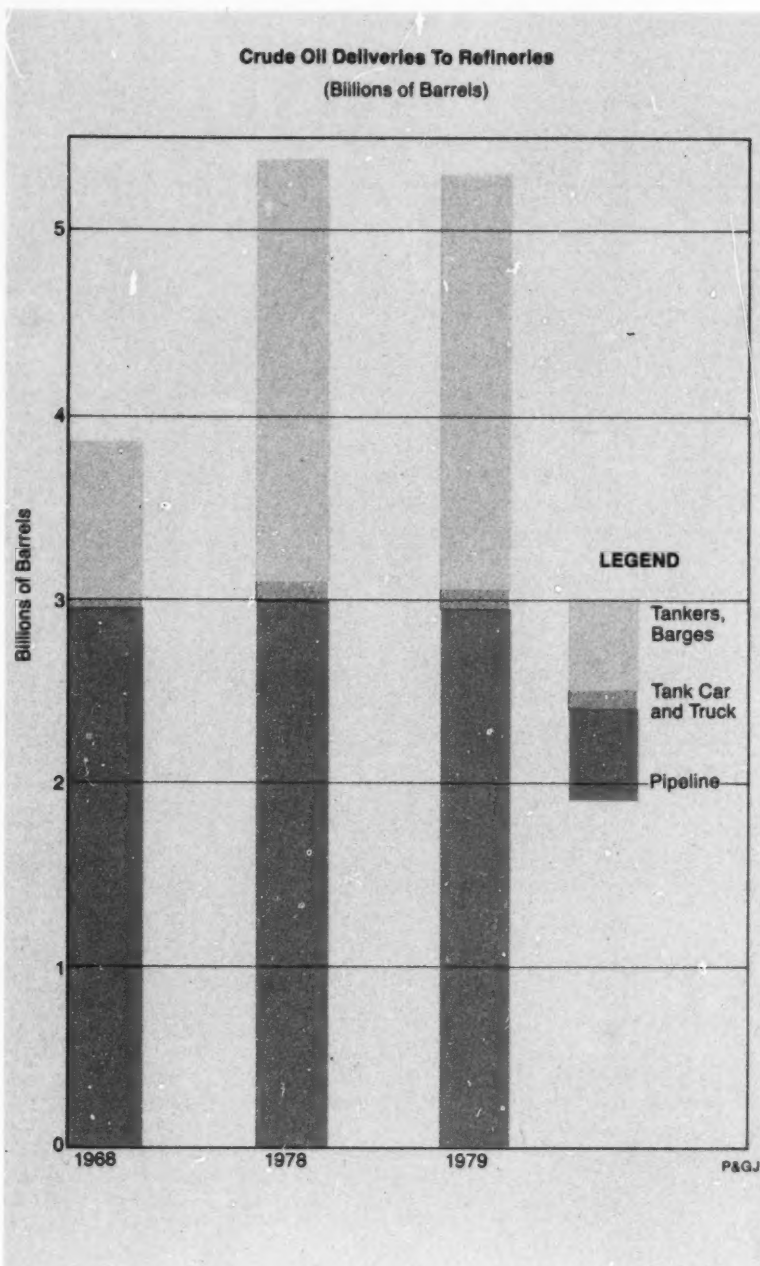
Gulf Oil Co. has 125 miles of 6-through 20-in. planned in three offshore projects in Louisiana.

Southern Union Refining Co. plans a 47-mile, 8-in. between Midland, Tex. and Lovington, N. Mex.

Wallace & Wallace Chemical & Oil Corp. has proposed a 214-mile, 22-through 30-in. crude line between Tuskegee and Mobile, Ala. **P&GJ**

Crude Pipeline Volumes Down, Products Line Deliveries Up

by John P. O'Donnell



Increasing dependence on foreign crude oil and decreasing demand for gasoline are among a number of factors that are changing long-standing patterns in liquid pipeline traffic.

More significant of these changes include:

1. Pipelines are moving a much smaller share of the crude oil deliveries to refineries,

2. Gasoline represents a declining share, and natural gas liquids a growing share, of the products pipeline mix, and

3. The products pipeline movement from the Gulf Coast to the Midwest, led by natural gas liquids, has dropped sharply.

In 1969, pipelines delivered more than 75% of the crude oil received at refineries and tankers and barges, about 22%. In 1979, the share of the deliveries made by pipeline dropped to 56%, while that of tankers and barges rose to over 42%.

The change in the proportions between the two modes of transportation resulted entirely from a huge increase in tanker deliveries. They were up more than 2½ times while deliveries by pipeline were practically unchanged.

While the total volume of crude oil delivered to refineries by pipeline is virtually unchanged from a decade ago, there are some pronounced changes in the origin of the crudes pipelines handled (Table 2). They handle less domestic crude, both intrastate and interstate, but more than three times as much foreign crude. The volume of intrastate crude was down more than that of interstate.

Pipeline deliveries of refined products continued to increase last year despite a drop in gasoline, which has represented 55% of the products pipeline mix. This continued a trend that has persisted through the past decade as gains in other products offset the drop in gasoline.

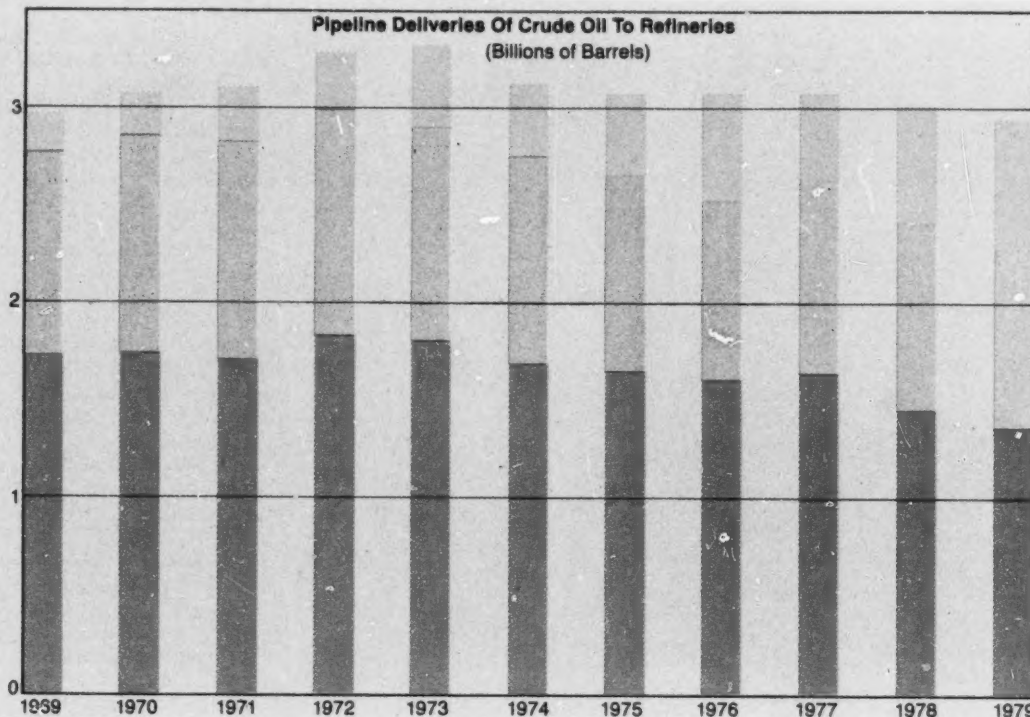
Today's more fuel-efficient cars and

TABLE 1
Crude Oil Deliveries to Refineries

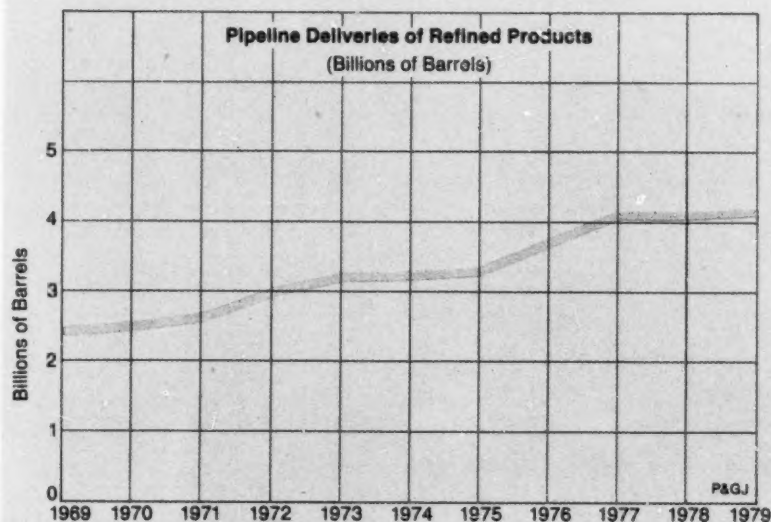
Transportation Means	1969		1978		1979	
	(1,000 bbl)	Percent	(1,000 bbl)	Percent	(1,000 bbl)	Percent
Pipeline	2,969,278	76.6	3,012,031	56.1	2,949,829	55.6
Tank cars, trucks	47,833	1.2	94,249	1.7	109,053	2.0
Tankers, barges	861,412	22.2	2,266,710	42.2	2,249,478	42.4
Totals	3,878,523	100.0	5,392,990	100.0	5,308,360	100.0

TABLE 2
Pipeline Deliveries of Crude Oil to Refineries
 (Thousands of Barrels)

Year	Intrastate	Interstate	Foreign	Total
1969	1,715,126	1,054,931	199,221	2,969,278
1970	1,730,513	1,109,354	236,798	3,076,665
1971	1,702,214	1,132,284	260,361	3,094,859
1972	1,832,042	1,131,777	317,774	3,281,593
1973	1,796,892	1,108,101	408,740	3,313,733
1974	1,692,458	1,061,441	370,654	3,124,553
1975	1,641,014	1,020,686	413,183	3,074,883
1976	1,599,059	937,393	560,731	3,097,183
1977	1,622,620	1,020,118	443,026	3,085,764
1978	1,461,922	962,008	563,129	2,987,059
1979	1,365,543	912,802	671,484	2,949,829



LEGEND Intrastate Interstate Foreign



more conservative driving habits dropped gasoline's share of the mix from just under 55% in 1978 to slightly less than 53% in 1979. All other products were up with the largest gain coming in natural gas liquids. They accounted for 16.4% of the mix in 1979 against 15% in '78.

Natural gas liquids have increased their share of the mix steadily over the past ten years. They were 12% of the total in 1969 and 16.4% in 1979.

The big products pipeline movement continues to be that from the Gulf Coast to the East Coast. In 1979 this movement topped 2,000,000 bbl per day for the first time. This dependence of the East Coast on Gulf Coast refining capacity is, of course, a reflection of the continued refusal of authorities along the Atlantic seaboard to permit new refinery construction.

Such shipments did decline in 1974,

TABLE 3
Pipeline Deliveries of Refined Products
(Thousands of Barrels)

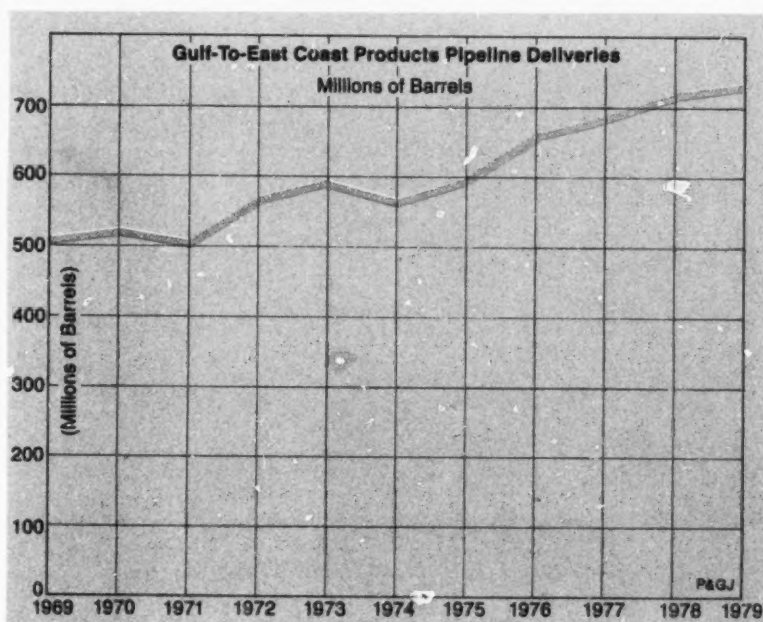
Year	Gasoline	Jet Fuel	Kerosine	Distillate Fuel Oil	Natural Gas Liquids	Other	Total
1969	1,358,579	179,920	68,185	540,482	292,763	0	2,439,909
1970	1,423,395	187,928	61,359	559,785	327,926	0	2,559,763
1971	1,466,816	204,736	51,202	583,230	338,796	0	2,644,780
1972	1,638,756	226,317	46,132	659,409	397,326	0	2,987,940
1973	1,760,580	247,035	45,086	720,997	431,228	0	3,204,926
1974	1,774,498	244,719	35,822	701,650	468,567	0	3,225,256
1975	1,822,830	259,578	30,864	667,058	504,714	0	3,285,044
1976	2,003,207	323,233	30,399	745,335	567,070	2,976	3,672,220
1977	2,205,041	344,285	34,876	858,463	603,847	2,349	4,063,164
1978	2,255,774	355,691	29,343	851,683	618,514	1,486	4,112,491
1979	2,205,914	379,428	29,982	866,127	684,921	3,325	4,169,697

TABLE 4
Changes in Products Pipeline Mix
(Thousands of Barrels)

Product	1969		1978		1979	
	Quantity	Percent	Quantity	Percent	Quantity	Percent
Gasoline	1,358,579	55.7	2,255,774	54.9	2,205,914	52.9
Jet Fuel	179,920	7.4	355,691	8.7	379,428	9.1
Kerosine	68,185	2.8	29,343	0.7	29,982	0.7
Dist. Fuel Oil	540,482	22.1	851,683	20.7	866,127	20.8
Nat. Gas Liq.	292,763	12.0	618,514	15.0	684,921	16.4
Totals	2,439,909	100.0	4,112,491	100.0	4,166,372	100.0

TABLE 5
Products Pipeline Deliveries from Gulf to East Coast
(Thousands of Barrels)

Year	Gasoline	Jet Fuel	Kerosine	Distillate Fuel Oil	Natural Gas Liquids	Totals
1969	285,058	40,750	16,580	160,203	12,060	514,653
1970	299,022	42,085	15,478	156,875	13,089	526,549
1971	286,379	41,194	14,646	155,534	14,705	512,458
1972	307,159	49,332	12,959	179,493	16,603	565,546
1973	329,835	55,504	11,134	180,331	18,112	594,916
1974	321,271	51,375	8,147	173,417	15,846	570,056
1975	353,513	50,448	8,719	167,474	17,380	597,534
1976	394,587	52,622	10,963	183,913	19,796	661,883
1977	416,523	54,951	10,299	190,892	18,932	691,597
1978	436,105	61,238	9,552	194,210	19,894	720,999
1979	437,684	65,411	10,066	204,366	22,293	733,820



following the Arab oil embargo, but resumed their climb the following year and have since continued to increase. They were 43% higher in 1979 than they were 10 years earlier.

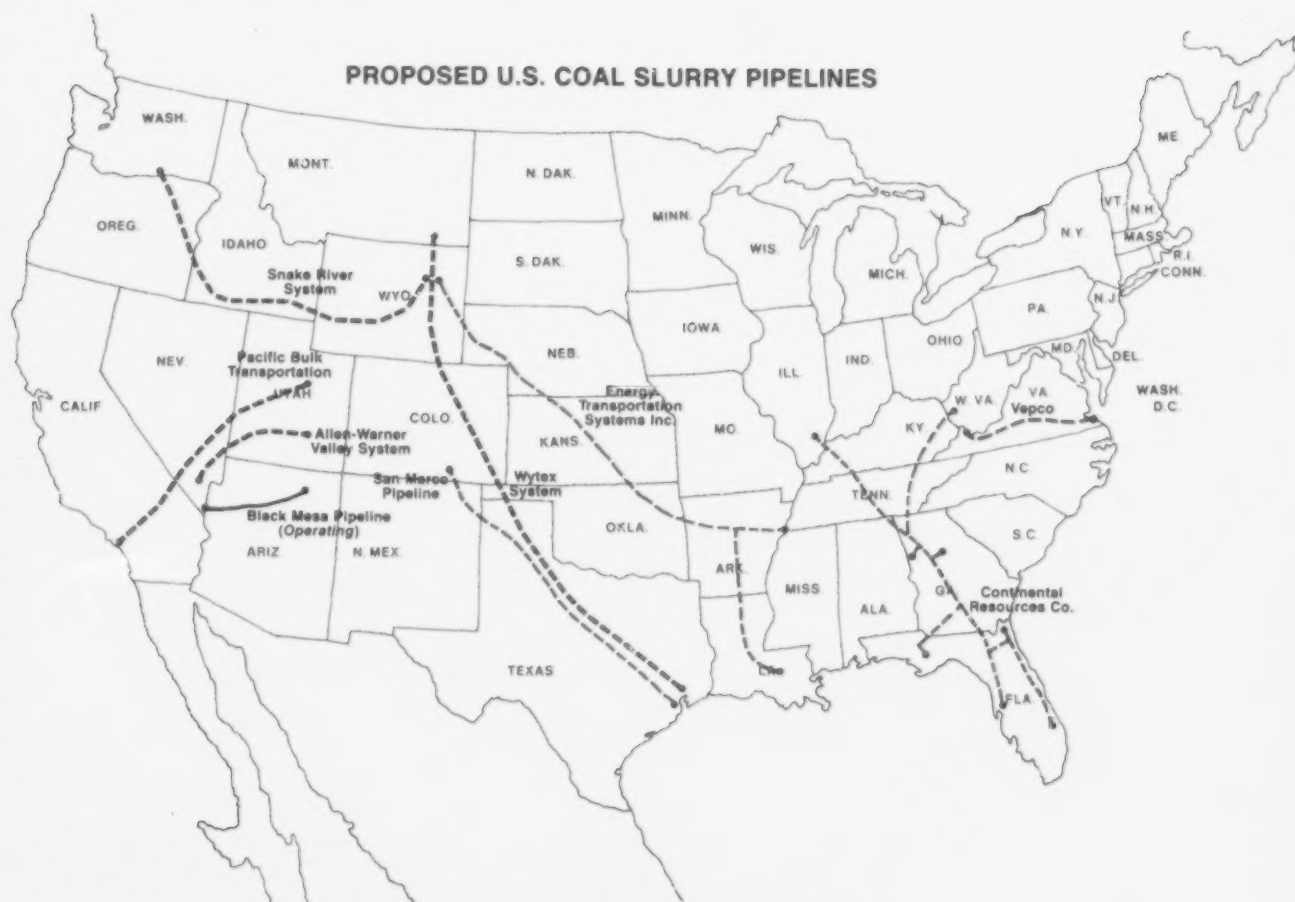
The dominance of the Gulf Coast-East Coast movement is shown in a comparison between it and the Gulf Coast-Midwest movement, the second largest. It's almost four-to-one.

Products shipments from the Gulf Coast (District 3) to the Midwest (District 2) dropped sharply last year. They fell from 227 million bbl in 1978 to 197 million bbl in 1979, a drop of 13%. Almost all the decline, surprisingly, was in natural gas liquids, down 38 million bbl or 28%.

There were no particularly significant changes in other interdistrict movements except between Districts 1 and 2. Shipments from District 1 to 2 were down 5 million bbl and from District 2 to 1, up 5 million, equivalent to a net gain of 10 million bbl for the East Coast.

P&GJ

Slurry Pipelines Report



Slurry Projects Moving Ahead, Over 8000 Miles Planned

by Dean Hale, Editor

Coal slurry pipeline proponents continue to be optimistic about the future of moving coal hydraulically through long distance pipelines in competition with other transportation forms despite two major obstacles — lack of federal legislation giving them right of *eminent domain* and access to water needed to make the slurry.

Both of the obstacles are being overcome through continuing education of Congress and state legislative bodies, and through research and technological developments. Current economics may also be on the side of the long distance pipelines, whose studies indicate that they can operate more cheaply than other transportation methods whose costs continue to skyrocket and whose coal transportation rates have

steadily increased.

Presently, there are nine announced coal slurry projects in the U.S., involving some 8271 miles of pipeline planned, proposed, or under study.

Energy Transportation Systems, Inc.'s proposal involving 1378 miles of either 38- or 42-in. to transport up to 37.5 million tons of coal per year from Wyoming's Powder River Basin to electric generating plants in Oklahoma, Arkansas, and Louisiana is the most advanced of these projects. ETSI is also studying the possibility of building a trans-shipping point on the Mississippi River.

ETSI has won all 65 court cases it filed to validate its right to cross under railroad tracks at key locations along

its pipeline route. Four of the decisions were appealed to the U.S. Circuit Courts, and all four appeals were denied. The affected railroad has decided not to protest them to the U.S. Supreme Court. Two remaining appeals are before the Oklahoma Supreme Court. ETSI currently has state eminent domain rights, favorable court rulings, or railroad concurrence in all of the six principal states through which its pipeline will pass. ETSI says it expects to acquire non-railroad right-of-way for the length of the pipeline under normal procedures.

State air pollution control permits for three slurry preparation plants in the Powder River Basin have been issued to ETSI by the Wyoming Department of Environmental Quality. At the plants, where coal will be

crushed and mixed with water to form the slurry, wet scrubbers will be used to suppress coal dust during crushing operations.

ETSI was granted state approval in 1974 to use up to 20,000 acre feet of water per year from the Madison Formation, a deep underground aquifer. The firm, anticipating greatly accelerated demand for domestic coal because of conversion from petroleum and natural gas, has enlarged the scope of studies of the project to consider building a 42-in. line with the larger 37.5 million tons per year coal-carrying capacity.

The environmental impact statement for the ETSI project is well along following public "scoping" meetings held in late 1979 by the Bureau of Land Management. Full public hearings are planned for late 1980 and BLM expects the final EIS to be completed by mid-1981.

Work on a coal evaluation program to confirm the behavior of specific coals to be shipped in the line — is underway and is to be completed in 1981. Negotiations on firm contracts are also continuing with several shippers.

ETSI's goal is to begin construction in 1982 and have the pipeline operating in 1984.

San Marco Pipeline Co., owned jointly by Houston Natural Gas Corp. and Rio Grande Industries (parent company of the Denver & Rio Grande Western Railroad), is planning a 900-mile, 20- and 24-in. slurry pipeline system to deliver 10 million tons of coal annually to the Texas Gulf Coast area.

San Marco's concept would use the Rio Grande rail system as a coal gathering network to collect the coal at a slurry preparation facility at Walsenburg, near the southeast corner of Colorado.

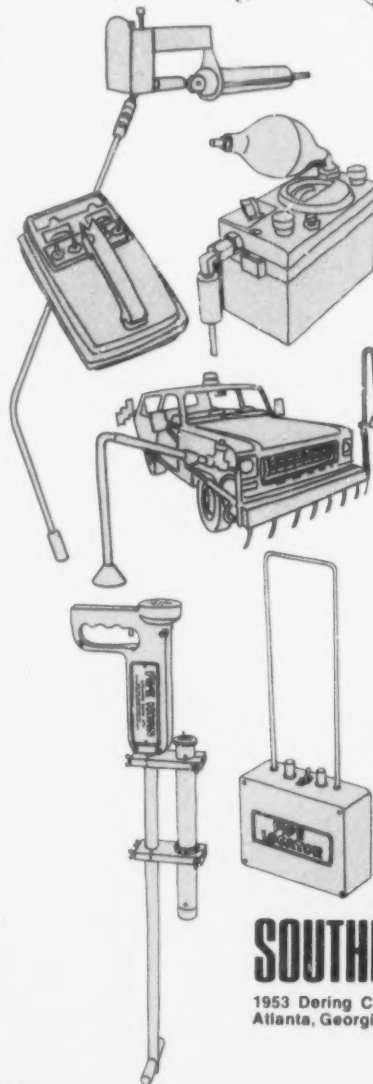
Acquisition of a usable water supply is the main thrust of the project and San Marcos has acquired land southeast of Alamosa, Colo. as a center for its water exploration program. Extensive seismic and aerial magnetron work has been conducted, and some 45 wells have been drilled on the company property and surrounding area. The test program has proven successful to date and San Marcos believes it has found an exceptionally good reservoir and that the water source is not tributary to any stream or compact. The firm has filed for 15,000 acre feet of water per year through the Colorado water court system.

Continental Resources Co. (formerly Florida Gas Co.) has proposed a 1500-mile system that would transport coal from areas in southern Illinois, western West Virginia, Kentucky, and Tennessee to electric generating plants in Georgia and Florida. Pipe



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sizes would range from 14- to 36-in. and annual capacity would be approximately 30 million tons. Water supplies are not believed to be difficult because of the stream flow in the Ohio River Basin. Right-of-way acquisition might be more difficult because of the small size of parcels of land and the difficult terrain encountered in the eastern and southeastern regions.

Nevada Power Co.'s Allen-Warner Valley Energy Systems project, would transport coal in slurry form in the states of Utah, Arizona, and Nevada to supply two new power plants. The Department of Interior is currently reviewing the environmental impact statement of the project. The pipeline—183 miles of 22-in.—would transport 11.6 million tons of coal annually over isolated, high, dry plateau country. A major problem faced by the project is that of obtaining a permit to mine coal in southwest Utah near the Bryce and Zion National Parks.

Texas Eastern Corp., in conjunction with Brown & Root, has proposed the Wytex System, a 1260-mile, 36- and 40-in. coal slurry pipeline from the Powder River Basin of Wyoming to the Houston area to move about 22 million tons of coal per year.

The project currently is "on hold" because Wyoming Gov. Herschler stopped further consideration by denying the project water under legislation passed by the Wyoming State Legislature.

Snake River Pipeline System, a joint venture of Northwest Energy Co. and Gulf Interstate Engineering Co., Houston, proposes to move 10 million tons of coal annually through a 1100-mile pipeline to supply—initially—new steam-electric generating plants at Boardman, Ore. and Boise, Ida. Other utility generating plants would be required as customers to hasten development of the project.

Pacific Bulk Transportation Systems, proposed by Boeing Engineering and Construction Co., would function as a transportation system for coal in slurry form that is destined for export shipment to Japan, Korea, and Taiwan. Boeing's proposal involves a 650-mile pipeline from central Utah to a port facility near Oxnard, Calif. Water sources for the project are secure, says Boeing, and eminent domain would not be necessary to transport the coal to the West Coast. The project, however, has not advanced beyond the feasibility stage.

Tesoro Petroleum Corp. has announced a major coal slurry proposal, involving 1000 miles of pipeline that would transport coal from Kentucky mines to electric generating plants in the southeastern states. Project feasibility is being studied for Tesoro by Fluor Corp. and Dames & Moore.

Virginia Electric Power Co. of Richmond, Va. has its proposal for a 300-mile, 12- to 36-in. coal slurry pipeline in the advanced feasibility study state. The line, which would originate at Proud, W. Va., would transport coal for use in coal-fired electric generating stations in Virginia, extending to Portsmouth, Va. A major obstacle is that Virginia is the only state with a law specifically blocking coal pipelines from using the power of eminent domain to obtain land for the pipeline route. Repeal of the state law would be necessary to build the pipeline.

Legislation Progress

The Coal Pipeline Act of 1980 (H.R. 4370) is currently being considered in the U.S. House of Representatives. This bill was introduced by a number of members from Texas—Eckhardt of Houston, Loeffler and Kazen of San Antonio, Wright of Ft. Worth. Udall of Arizona is also a sponsor. A similar bill was also reported by the House Interior Committee. Hearings on H.R. 4370 have been held by a subcommittee of the House Public Works Committee and a markup to full committee consideration was planned for late May. A final bill for full House consideration would have to involve a reconciliation of differences between the Interior version and the Public Works version.

Among those differences is that the Interior Committee bill has the Department of Interior as a certifying agency for private lands where the right of eminent domain would be used and the Public Works Committee Bill has the Interstate Commerce Commission as certifying agency for railroads, et al.

In early May, Sen. Dale Bumpers, D-Ark, introduced a bill (S.2665) that would amend the Mineral Leasing Act and give right of eminent domain to coal slurry pipelines. Hearings on this bill were expected to begin in late May by a subcommittee of the Senate Energy Committee, chaired by Sen. Bumpers.

Economic Study Reported

Just one major coal slurry pipeline could save electric utility customers from \$4 to \$8 billion during the decade of the '90s, a national consulting firm has estimated. Residential customers would get about 45% of the savings directly, according to the study by National Economic Research Associates, Inc. (NERA). The NERA study utilized data from a feasibility study by Continental Resources Co. of its proposed coal slurry pipeline from Southern Appalachia and southern Illinois coal basins to Georgia and Florida.

The study projected cost differen-

U.S. COAL SLURRY PIPELINE PROJECTS

Company	Miles	Size (In.)	From	To	Annual Tonnage
Energy Transportation Systems Inc.	1378	38 or 42	Powder River Basin, Wyo.	Oklahoma, Arkansas, Louisiana, Texas Gulf	25 MM to 37 MM
San Marce Pipeline Co. (Houston Natural Gas, Rio Grande Industries)	900	20/24	Southeast Colorado-New Mexico Border		15 MM
Allen-Warner Valley Energy Systems (Nevada Power Co.)	183	22	Alton, Utah	Las Vegas, Nev.	11.6 MM
Continental Resources Co.	1500	14/36	So. Illinois-E. Kentucky-Tennessee	Georgia, Florida	30 MM
Virginia Electric Power Co.	300	12/36	Proud, W. Va.	Portsmouth, Va.	10 MM
Wytex System (Texas Eastern, Brown & Root)	1260	36/40	Powder River Basin, Wyo.	Houston, Tex. area	22 MM
Snake River System (N.W. Energy, Gulf Interstate)	1100	N.A.	N.E. Wyoming	Idaho, Oregon	10 MM
Pacific Bulk Transportation Systems (Boeing Engineering & Construction Co.)	650	N.A.	Central Utah	Oxnard, Calif.	10 MM
Tesoro Petroleum Corp.	1000	N.A.	Kentucky	Southeastern States	N.A.

tials in coal transportation ranging from \$2.04 per ton 1990 to \$20.74 per ton in 2000, with the major expense increase being in fuel and wages by competing transport forms. Fuel savings alone would involve 3,337,000 bbl of diesel fuel in 1990, and up to 4,845,000 bbl in the year 2000.

Technological Advances

Serious consideration is being given to the carrying mediums for coal as a slurry in pipelines. Rather than use the 50% coal-50% water ratio used by the nation's major operating coal slurry pipeline—the Black Mesa Pipeline in Arizona—researchers are aiming

for a 70% coal-30% water mixture.

Other proposals involve the use of liquid carbon dioxide as a carrying medium for coal from the Powder River Basin in Wyoming in an open-loop system. The CO₂ would be recovered and used for tertiary recovery in some of the older oilfields in Texas. Also being considered is a closed-loop in which the CO₂ would be recovered and returned to the origin end of the slurry pipeline. In such a system, a second, smaller pipeline would be required for the return movement.

Crude oil has also been suggested as a medium for carrying coal slurry. Such a system would require develop-

ment of plants (or modification of existing oil refineries) to utilize a coal-oil mixture to also produce coal derived liquids and products.

Methanol has also been proposed as a coal carrying medium. Methanol can be manufactured from coal and fuel-grade methanol is a clean boiler fuel and/or gasoline substitute. Research to date indicates that methanol could be effectively used, but considerable development and research work still must be performed.

Finally, technology is advancing in the coarse—or heterogeneous—slurry system area. This approach is used primarily in moving coal to the surface from deep mines. Such systems would make it possible for a requisite amount of coal to be mined to feed coal gasification plants, coal liquefaction plants, and mine-mouth generating stations. The DOE is spending \$7 million to develop such a system to work in a 4-ft seam to move coal to the surface at rates of five to seven tons per minute.

European Slurry Pipelines

Only two slurry lines of any significance exist in Western Europe today and prospects for further development of slurry pipelines will depend on their having great economic advantages. That's because existing transport networks—highways, railroads, and waterways—are well developed, reliable, and heavily subsidized by government.

Despite those facts, there are at least eight major slurry pipeline prospects being given consideration today, and some of those are expected to eventually come into being. They include:

Iron Ore Slurry Pipelines

	Tons/Yr
1. Rotterdam to Ruhr District	36 MM
2. Zeebrugge or Dunkirk to Luxembourg and Saar District	N.A.
3. Trieste or Bakar to Linz, Austria (500 km)	N.A.
4. North Sea to Salzgitte (250 km)	3 MM

Coal Slurry Pipelines

5. Ruhr District to S. Germany (548 km)	2.24 MM
6. Ruhr District to Salzgitte (200 km)	3-4 MM
7. Katowice, Poland to Linz, Austria (400 km)	5 MM
8. Saar District — Local Delivery (30 km)	2 MM

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"Windfall Profits" Tax Impact Felt

by Julie Fonner, Assistant Editor
Energy Management Report

The "windfall profits" tax (WPT) went into effect March 1, 1980. Oil companies felt its impact in their first quarter reports.

Standard Indiana said "the impact of the 'windfall profits' tax will grow substantially as the crude oil price decontrol program progresses."

Cities Service, Superior Oil, Texaco, Conoco, Shell all reported domestic earnings diminished by WPT.

Atlantic Richfield paid \$31 million in "windfall profits" taxes in the first quarter; Standard Oil of California paid \$24 million; South-

land Royalty paid \$3.4 million; Standard Indiana paid \$34 million; Gulf Oil paid \$31 million. (These millions in taxes were paid on operations for the month of March only.)

Sohio's response to WPT: "Despite this major setback in funding energy development, Sohio intends to do its best to find and develop new energy resources within the restrictions imposed by this new excise tax."

Phillips Petroleum said "Higher taxes, both in the U.S. and abroad, and lower profit margins in domestic refining/marketing

operations and chemical activities are expected to adversely affect earnings during the last nine months of the year."

Gas companies reported increased oil/natural gas volumes from their production departments. United Energy Resources' Cotton Petroleum increased gas production 42%. Houston Natural Gas increased gas production 56%.

TransCanada PipeLines acquired interest in oil/gas properties in western Canada in 1979. "While no significant net earnings contribution is estimated from oil/gas properties this year, this operation has a

FIRST QUARTER GAS COMPANIES FINANCIAL REPORTS

	Three months ending March 31**					
	Revenues (\$000)			Earnings* (\$000)		
	1980	1979 % Chg.		1980	1979 % Chg.	Profit Margin* 1980 1979
Alabama Tennessee N.G.	26,778	14,673 + 82.5		1,324	805 + 64.5	4.9 5.5
Alberta Gas Trunkline	480,800	141,400 +240.0		29,338	20,350 + 44.2	6.1 14.4
American Nat. Resources	976,333	710,873 + 37.3		54,160	53,576 + 1.1	5.5 7.5
Arkla Gas Co.	286,312	186,992 + 53.1		35,922	22,972 + 56.4	12.5 12.3
Coastal Corp.	1,446,364	987,071 + 46.5		26,391	20,755 + 27.2	1.8 2.1
Columbia Gas	1,303,000	992,432 + 31.3		83,800	80,425 + 4.2	6.4 8.1
Commonwealth Nat. Res.	70,095	45,223 + 55.0		3,075	2,440 + 26.0	4.4 5.4
Consolidated N.G.	953,206	704,316 + 35.3		70,003	62,452 + 12.1	7.3 8.9
El Paso Companies	1,028,388	559,179 + 83.9		34,748	31,289 + 11.1	3.4 5.6
Enserch Corp.	694,687	579,299 + 19.9		45,290	33,066 + 37.0	6.5 5.7
Equitable Gas	125,326	104,659 + 19.7		16,680	14,302 + 16.6	13.3 13.7
Internorth Inc.	938,396	685,547 + 36.9		111,114	71,512 + 55.4	11.8 10.4
Kansas Nebraska N.G.	99,162	85,845 + 15.5		8,197	7,571 + 8.3	8.3 8.8
Mountain Fuel Supply	129,025	105,492 + 22.3		14,950	12,215 + 22.4	11.6 11.6
National Fuel Gas ¹	489,658	388,880 + 25.9		30,978	29,119 + 6.4	6.3 7.5
Northwest Energy	431,500	290,000 + 48.8		18,100	11,200 + 61.6	4.2 3.9
Oklahoma N.G. ²	277,401	242,516 + 14.4		17,498	16,914 + 3.5	6.3 7.0
Pacific Lighting	901,195	544,655 + 65.5		22,700	30,406 - 25.3	2.5 5.6
Panhandle Eastern	657,187	487,100 + 34.9		60,878	52,544 + 15.9	9.3 10.8
Peoples Energy	1,075,862	819,922 + 31.2		66,242	68,662 - 3.5	6.2 8.4
Pioneer Corp.	210,483	157,815 + 33.4		23,430	12,009 + 95.1	11.1 7.6
Southern Nat. Res.	553,215	381,853 + 44.9		37,194	27,978 + 32.9	6.7 7.3
Southern Union Co.	255,708	196,215 + 30.3		18,048	14,061 + 28.4	7.1 7.2
Texas Eastern Corp.	1,090,881	684,884 + 59.3		63,851	51,592 + 23.8	5.9 7.5
Texas Gas Trans.	585,333	406,192 + 44.1		25,073	15,929 + 57.4	4.3 3.9
TransCanada PipeLines	782,892	627,315 + 24.8		22,050	20,889 + 5.6	2.8 3.3
Transco Companies	586,235	339,362 + 72.7		28,357	15,144 + 87.2	4.8 4.5
United Energy Res.	1,034,782	671,010 + 54.2		41,702	26,402 + 58.0	4.0 3.9
Westcoast Trans.	436,986	276,215 + 58.2		12,728	12,651 + 0.6	2.9 4.6
TOTAL	17,927,190	12,416,935 + 44.4		1,023,821	839,230 + 22.0	5.7 6.8

*Earnings available to common. **Excluding non-recurring items. ¹Six Months.

²Three months ending Feb.29

FIRST QUARTER OIL COMPANIES FINANCIAL REPORTS

	Three months ending March 31*					
	Revenues (\$000)			Earnings* (\$000)		
	1980	1979	% Chg.	1980	1979	% Chg.
Profit Margin†						
	1980	1979			1980	1979
1. Adams Res. & Energy	62,511	30,327	+105.5	(118)	156	none
2. Adobe Oil & Gas	36,085	17,543	+105.7	4,381	1,970	+122.4
3. Alaska Interstate	82,995	55,969	+48.3	14,221	978	+1354.1
4. Altex Oil	238	116	+105.2	24	(224)	10.1
5. Amarex Inc.	4,650	3,488	+33.3	747	691	+8.1
6. Amerada Hess	2,525,598	1,538,611	+51.1	180,178	129,694	+38.9
7. American Petrofina	523,374	345,647	+51.4	31,410	11,360	+176.5
8. American Quasar	9,075	6,944	+30.7	2,005	625	+220.8
9. Argo Petroleum	3,229	1,901	+70.0	474	5	+9380.0
10. Ashland Oil	2,000,000	1,500,000	+33.3	47,400	30,600	+54.9
11. Atlantic Richfield	5,433,767	3,516,918	+54.5	426,119	242,211	+75.9
12. Baruch Foster	1,704	560	+204.3	487	78	+524.4
13. Beard Oil	5,708	2,304	+147.7	1,202	440	+14925.0
14. Belco Petroleum	211,543	125,267	+68.9	18,243	14,405	+26.6
15. Buttes Gas & Oil	40,217	32,348	+24.3	3,186	612	+420.6
16. C&K Petroleum	8,663	6,521	+32.9	1,121	374	+199.7
17. Callon Petroleum	2,885	2,210	+30.5	1,100	422	+160.7
18. Cities Service	2,172,000	1,445,600	+50.3	170,100	78,500	+116.7
19. Clark O&R	402,274	258,198	+55.8	14,100	6,087	+131.6
20. Commonwealth OR	306,200	236,200	+29.6	(9,200)	10,500	none
21. Consolidated O&G	7,959	6,927	+14.9	219	(2,284)	2.8
22. Conoco Inc.	4,330,000	2,750,800	+57.4	328,600	161,800	+103.1
23. Crestmont O&G	3,101	1,620	+91.4	1,128	440	+154.6
24. Crown Central	306,230	217,117	+41.0	11,478	16,210	-29.2
25. Crystal Oil	58,321	28,493	+104.7	2,887	1,091	+164.6
26. Damsen Oil	7,240	4,258	+70.0	465	(379)	6.4
27. Delhi Int'l Oil	5,596	3,244	+72.5	1,112	578	+92.4
28. Diamond Shamrock	755,331	505,005	+49.6	56,255	29,529	+90.5
29. Dorchester Gas	174,778	77,771	+124.7	7,583	4,138	+83.3
30. Dyco Petroleum	6,118	5,573	+9.7	1,610	792	+103.3
31. Energy Reserves Group	36,044	18,837	+91.3	8,487	(3,089)	23.5
32. Equity Oil	3,209	2,667	+20.3	861	544	+54.6
33. Exxon	27,654,000	18,828,000	+46.9	1,925,000	955,000	+101.6
34. Felmont	11,948	9,126	+30.9	3,749	2,452	+52.9
35. Forest Oil	21,464	17,774	+20.8	2,123	2,087	+1.7
36. Galaxy Oil	2,341	1,264	+101.0	253	(238)	10.0
37. General American	61,491	41,365	+48.7	13,722	8,053	+70.4
38. Getty Oil	2,268,699	1,095,691	+107.1	225,548	107,930	+109.9
39. Gulf Energy & Develop.	19,341	6,907	+180.1	1,353	561	+141.2
40. Gulf Oil Corp.	7,756,000	5,566,000	+39.4	389,000	249,000	+56.2
41. Heimerich & Payne	55,739	30,315	+82.3	11,930	7,535	+58.3
42. Houston O&G	97,282	81,642	+19.2	14,590	13,057	+11.7
43. Howell Corp.	69,286	58,832	+17.8	7,004	2,723	+157.2
44. Husky Oil Ltd.	270,700	188,300	+43.8	16,200	9,100	+78.0
45. Ineco Inc.	30,246	22,210	+36.2	5,747	3,739	+53.7
46. Intercontinental Energy	2,226	1,896	+17.4	(523)	(165)	none
47. Juniper Petroleum	6,853	2,850	+142.2	1,491	152	+880.9
48. Kerr McGee Corp.	780,394	601,893	+29.7	47,142	33,442	+41.0
49. Kirby Exploration	20,202	10,692	+89.9	2,733	1,232	+121.8
50. Lear Petroleum	23,065	20,743	+11.2	1,865	1,376	+35.5
51. Louisiana Life	264,054	160,477	+65.1	31,593	33,770	-52.8
52. MCF Oil	14,975	12,054	+24.2	1,255	385	+226.0
53. Mapco Inc.	239,742	152,738	+57.0	20,588	15,356	+54.2
54. Marathon Oil	2,265,368	1,473,689	+53.7	139,071	80,838	+72.0
55. Maynard Oil	6,860	4,353	+57.6	1,392	166	+738.6
56. McCulloch Oil	26,073	15,434	+68.9	2,419	963	+151.2
57. McFarland Energy	3,389	1,626	+108.4	1,065	321	+231.8
58. McMoran Oil & Gas	11,300	4,404	+156.6	2,356	362	+550.8
59. McKee Consol. O&G	31,051	19,377	+60.3	212	1,332	-84.1
60. Mesa Petroleum	100,578	55,308	+81.6	19,586	14,357	+36.4
61. Mitchell Energy	15,156	77,442	-80.4	15,873	8,767	+80.1
62. Mobil Corp.	15,278,483	10,402,247	+46.9	921,804	448,562	+105.5
63. Murphy Oil	569,245	363,583	+56.0	26,390	15,044	+75.0
64. Natomas	319,076	219,857	+45.1	48,015	18,275	+162.7
65. Noble Affiliates	67,584	46,965	+43.9	13,459	6,229	+116.1
66. Occidental Petr.	3,346,600	1,842,600	+81.6	158,300	82,600	+91.7
67. Ocean O&G	19,963	11,394	+75.2	3,494	1,978	+76.6
68. Oxo	2,437	1,799	+36.6	251	47	+434.0
69. Pacific Resources	206,960	114,587	+80.6	9,030	5,312	+72.6
70. Patrick Petroleum	12,533	11,040	+13.5	(299)	402	none
71. Pauley Petroleum	40,607	22,840	+77.8	934	(3,264)	2.3
72. Peninsula Resources	3,340	1,887	+77.0	153	119	+28.6
73. Pennzoil Co.	612,905	435,421	+41.4	82,501	44,954	+85.5
74. Petro-Lewis	28,341	13,830	+104.9	5,057	1,526	+231.4
75. Phillips Petroleum	3,384,162	1,987,024	+70.3	338,599	177,001	+91.3
76. Quaker State	194,860	157,155	+24.0	6,879	7,912	-13.1
77. Sabine Corp.	28,075	16,328	+71.9	6,349	2,155	+194.6
78. Seneca Oil	1,835	570	+221.9	325	62	+421.0
79. Shell Oil	4,796,000	3,076,000	+56.0	373,000	224,000	+66.5
80. Southland Royalty	20,635	51,300	-76.5	19,800	10,105	+95.1
81. Standard Calif.	10,447,000	6,958,000	+50.1	627,000	343,000	+82.8
82. Standard Indiana	6,452,600	4,382,300	+47.2	576,000	350,000	+64.6
83. Standard Ohio	2,514,800	1,650,500	+52.4	450,700	167,500	+169.1
84. Sun Co.	3,100,000	2,400,000	+29.4	251,500	128,300	+95.9
85. Sundance Oil	4,284	3,944	+8.6	(1,082)	(1,415)	none
86. Superior Oil	330,287	219,228	+50.7	68,366	40,327	+69.5
87. Supron Energy	15,056	11,139	+35.2	4,700	5,146	-49.4
88. Tenco	5,316,000	2,447,000	+55.5	178,000	123,000	+44.7
89. Tesoro	828,749	502,757	+64.8	41,639	9,104	+357.4
90. Texaco Inc.	13,249,000	8,358,000	+58.5	600,000	303,900	+97.6
91. Texas American	33,137	22,527	+47.1	686	217	+216.1
92. Texas International	14,207	6,318	+124.9	1,874	330	+467.9
93. Texas Oil & Gas	294,901	223,827	+31.8	34,783	23,967	+45.1
94. Tipperary Corp.	18,757	12,664	+48.1	1,381	(32)	7.4
95. Tomlinson Oil	14,393	6,160	+133.7	708	307	+130.6
96. Tosco Corp.	534,162	356,267	+49.9	22,629	11,101	+103.9
97. Total Petr. N.A.	314,589	174,050	+80.7	8,071	4,730	+70.6
98. Transcontinental Oil	17,900	16,357	+9.5	(124)	(907)	86.3
99. Triton Oil & Gas	5,409	2,956	+83.0	2,020	(235)	37.4
100. Union California	2,282,333	1,662,333	+37.3	152,922	114,104	+34.0
101. United Refining	149,284	102,169	+46.1	2,247	1,332	+68.7
102. Universal Resources	9,287	5,644	+64.6	1,372	613	+123.8
103. Valco Oil	9,546	5,378	+77.5	2,930	1,490	+96.6
104. Westcoast Petr.	9,720	8,400	+15.7	2,657	2,259	+17.6
105. Wichita Industries	2,197	998	+120.1	354	20	+1670.0
106. Williams Companies	479,337	422,133	+13.6	35,123	7,439	+347.1
107. Wiser Oil	15,112	8,599	+75.7	5,036	2,634	+91.2
108. Woods Petroleum	23,145	9,960	+132.4	3,065	2,745	+11.7
109. Worldwide Energy	9,932	6,889	+44.1	1,044	62	+1583.9
TOTAL	135,113,213	90,092,931	+50.0	9,356,600	4,970,989	+88.2

*Earnings available to common. ** Excluding non-recurring items. () Loss. †Earnings* divided by revenues. ‡Ending January 31. §Ending February 29. ¶Revenues include excise taxes.

strong impact on internal cash generation," TransCanada said.

Oil and gas exploration/production division of Texas Gas Transmission posted record first quarter earnings in 1980.

Consolidated Natural Gas said "earnings increase was due to improved results from Gulf of Mexico operations."

Alabama Tennessee Natural Gas said earnings increase was due to improved gas supply.

Peoples Energy said "revenues increased in the first quarter reflecting the pass-through of higher purchased gas costs and higher market prices for (subsidiary) Harper Oil's production. Offsetting factors included gas sales declines resulting from warmer weather and continuing softness in the coal market."

Southern Union's utility earnings were down during the first quarter due to warm weather—but refinery operations were up substantially.

Commonwealth Natural Resources cited "increased supply, greater industrial sales and higher cost of product" as dominant factors contributing to increased revenues. Natural gas sales were up 17.5%.

Profits per gallon of product sold for Mobil were 5.6¢ worldwide and 4.1¢ in the U.S. Texaco made 3.4¢/gal worldwide. Standard California reports 4.0¢ profit/gallon on worldwide product sales, 3.9¢/gal in the U.S.

Sohio's pump prices, "the lowest in the nation, resulted from government crude oil and product price regulations, as well as efficient marketing and higher refinery runs" says a Sohio release.

Equity Oil's gains were from operations in Rangely Weber Sand Unit in Colorado... Triton said its downward trend in oil/gas production has been "arrested by the success of our U.S. exploration effort, now in its third year."

Profits of Union California increased "due to improved domestic and foreign crude oil and natural gas earnings." Mesa's production was down but record earnings and revenues were achieved because of increased interest income and higher prices for new offshore production.

Natamas attributed increased earnings to Indonesian petroleum operations and said that U.S. pet-

roleum, geothermal, coal and petroleum marketing operations also showed gains. Noble cited strong performances in all operations—oil and gas, contract drilling and trucking.

Foreign petroleum and worldwide chemical and mineral operations accounted for 86% of the first quarter earnings gain for Standard Indiana. Domestic petroleum earnings were up only 16% over the first quarter 1979 results.

All Marathon's earnings improvement in the quarter ending

March 31 were from domestic sources. Net income from foreign sources was down from a year before.

Conoco attributed earnings improvement to higher margins for refined products and crude oil and increased crude oil production in the North Sea and Indonesia.

"Continued favorable results of refining and marketing activities" are cited as reasons for earnings increases for American Petrofina. ... Quaker State stated "the decline in earnings in the first quar-

ter of this year resulted from lower earnings in the petroleum operations because of higher prices paid for purchased crude oil."

United Refining said "higher refinery runs decreased the need to purchase refined products from other suppliers. However, earnings were constrained by higher crude costs and lower refined product sales volumes".

Pacific Resources attributed its earnings increase for the quarter to strong demand for higher margin petroleum products in the foreign and bonded fuel markets.

Earnings rise due to higher prices for crude and natural gas and increased production were cited by Shell Oil, Noble Affiliates, Phillips Petroleum, Atlantic Richfield, Union California, Mobil, Southland Royalty, Consolidated Oil & Gas.

Also Dyco Petroleum, Triton Oil & Gas, Gulf Oil, Exxon, Pennzoil, Husky Oil, Statex Petroleum, Texas Oil & Gas and Universal Resources. Texaco said it got higher prices but they were offset by lower production.

Tenneco says it is beginning to reap the results of its heavy investment in energy programs over the past five years—increasing production of both domestic oil and natural gas.

Dyco Petroleum realized the full impact of several deep new gas wells coming on production—some below 15,000 ft. "These deep wells qualify for deregulated gas prices and have significantly contributed to an increase in gas sales."

Some capital expenditure budgets are changed when the first quarter results are known. Standard California increased its budget to \$3 billion for all of 1980—two-thirds will be spent in the U.S.

Atlantic Richfield will spend \$3 billion in 1980; 70% in the U.S.; Cities Service is planning \$1 billion to be spent—up 45% from last year and more than double that of 3 years ago.

Union California will spend \$1.6 billion; 77% in the U.S. for exploration and production ... Conoco will spend \$2 billion; 60% in the U.S. ... Shell will spend \$3.1 billion; \$2.3 for energy projects.

Mobil said 38% of its first quarter capital spending was in the U.S.

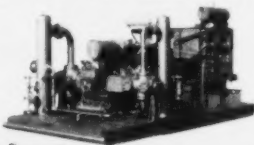
"The economics of using this KOA compressor are just right."



We had a group of shallow gas wells that just weren't producing enough to justify expensive compression equipment. But Ki's engineers designed a tailor-made compressor set around their KOA 100 hp unit and really turned things around.

We leased the package for a six-month trial then bought it when the lease term was up. Now we're netting substantial income from a lease that had been shut in for years.

KOA direct drive balanced-opposed compressors are available in packages of one to three stages with horsepower ranges up to 400 BHP. So if you have marginal production wells which have been shut in, chances are a Ki package could increase your cash flow, too.



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When it comes to compressors, Ki does it all. And does it better.